The New Standardized Approach for Measuring Counterparty Credit Risk

Master Thesis Project

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Abstract

This study investigates the differences in calculation of exposure at default between the current exposure method (CEM) and the new standardized approach for measuring counterparty credit risk exposures (SA-CCR) for over the counter (OTC) derivatives. The study intends to analyze the consequence of the usage of different approaches for netting as well as the differences in EAD between asset classes. After implementing both models and calculating EAD on real trades of a Swedish commercial bank it was obvious that SA-CCR has a higher level of complexity than its predecessor. The results from this study indicate that SA-CCR gives a lower EAD than CEM because of the higher recognition of netting but higher EAD when netting is not allowed. Foreign exchange derivatives are affected to a higher extent than interest rate derivatives in this particular study. Foreign exchange derivatives got lower EAD both when netting was allowed and when netting was not allowed under SA-CCR. A change of method for calculating EAD from CEM to SA-CCR could result in lower minimum capital requirements.

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Abbreviations

BIS	Bank for International Settlements
CCP	Central counterparty
CCR	Counterparty credit risk
CDO	Credit default obligation
CDS	Credit default swap
CE	Current exposure
CEM	Current exposure method
CO	Commodity
CR	Credit
CSA	Credit support annex
CVA	Credit valuation adjustment
EAD	Exposure at default
EQ	Equity
FX	Foreign exchange
HS	Hedging set
ICA	Independent collateral amount
IMM	Internal model method
IR	Interest rate
LGD	Loss given default
MPOR	Margin period of risk
MTA	Minimum transfer amount
MTM	Mark-to-market
NA	Netting agreement
NGR	Net gross ratio
NICA	Net independent collateral amount
NIMM	Non-internal model method
OTC	Over the counter
PD	Probability of default
PFE	Potential future exposure
RC	Replacement cost
RW	Risk weights
RWA	Risk weighted assets
SA-CCR	Standard approach for measuring counterparty credit risk exposures
SF	Supervisory factor
SFT	Securities financing transaction
SM	Standard method
TH	Threshold
TRS	Total return swap

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Part I
Introduction

Counterparty credit risk (CCR) or simply counterparty risk, has been a frequently discussed topic the last couple of years, especially since the last financial crisis that culminated during 2008 and lead to a default of the American investment bank Lehman Brothers. The Financial Crisis Inquiry Commission was given the mission by the United States government to “examine the causes of the current financial and economic crisis in the United States”. The commission concluded that so called over the counter (OTC) derivatives were one contributing factor to the financial crisis and that these type of contracts made the damages of the evolving debt crisis even worse by fueling the destruction process of the already fragile house of cards [3]. The OTC markets, in general, lack transparency and even though they have been somewhat regulated this has not been done to a significant extent. Most of the OTC derivatives are bilateral contracts, i.e. between two parties and not centrally cleared or traded on an exchange. Before the crisis banks were considered to be “too big to fail” and they were therefore assigned a zero or almost zero probability of defaulting. What then happened to Lehman Brothers made the financial industry and regulators realize that assigning a bank a probability of default of zero or almost zero was not realistic. No one is too big to fail. In the aftermath of the most turbulent time of the financial market since the great depression, voices rose for more regulations of banks and OTC derivatives in particular to prevent another crisis and to create a more stable and transparent financial market environment. Therefore we have seen an increased level of regulations in recent years for how financial institutes should manage and measure their counterparty risk as well as financial risks in general. Banks are now required to hold more capital for the risks they are exposed to. The development of the standardized approach for measuring counterparty credit risk exposures (SA-CCR) is the latest in a row of new regulations introduced. The new method will replace the old and much criticized current exposure method (CEM) and change the way financial institutions calculate the exposure at default (EAD). This study might aims to give the reader an understanding of how the new method is implemented and how it can possibly affect a commercial bank’s minimum capital requirement when it takes effect in January 2017.

1 Exposure at default

Credit risk is the risk of a counterparty defaulting on their contractual obligations. Traditionally credit risk is associated with lending risk where the amount of risk is known throughout the lending period. When considering lending risk, only one of the counterparties is exposed to the credit risk and the risk is in that sense unilateral. CCR, on the other hand is bilateral since both parties can be exposed to credit risk depending on the market value of the contract throughout the holding period. Thus, CCR can be considered as a specific form of credit risk which includes the uncertainties around the future exposure and hence EAD. For a loan, as an example, EAD is known throughout the holding time of the contract (i.e. EAD is the face value of the contract) and is thus equal to the credit risk. For a derivative, on the other hand, the calculations are much more complex due to the fact that the value of the contract changes over time. The value of an interest rate swap, for example, depends on changes in the referenced interest rate and the value when the contract matures is unknown until the time of maturity. Thus, in the context of regulations, CCR often relates to the counterparty risk in derivatives and security financing transactions (SFT), which is used mainly for short selling or settlement purposes.

2 Development of bank regulation

Regulation of banks is important and has the purpose of minimizing the risk of banks defaulting. This is done in order to create confidence in the banking system and build a stable financial environment. This is, among other actions, realized through so called minimum capital requirements where regulators require banks to hold a capital buffer in accordance to the risks they are exposed to. The first international standard, known as the Basel Accord (Basel I) was introduced 1988 [8] but has been developed and modified throughout the years due to factors such as changed market conditions and increased market complexity.

Basel I, when introduced, was mainly focused on credit risk whereas amendments were developed which included other risk factors and new aspects. For example an amendment, published in 1996, also included regulations regarding market risk [9]. In 2004 a second accord, mainly known as Basel II [10], was published which also included operational risk among other factors. Basel II together with Basel III [13], published 2010, have set the ground rules for regulation of banks today. Even though many different risk factors and quotas have been introduced, credit risk still remains the most important risk within the regulation framework.

The Basel regulations, as of today, include three pillars which incorporate rules regarding: minimum capital requirements, supervisory review and market discipline. Hence, the first pillar contains rules for how to calculate the so called minimum capital requirement that the bank needs to hold. The part of this capital that is related to credit risk is usually known as the regulatory credit risk capital. Here, EAD is a factor in the calculation of the regulatory CCR capital which is a part of the regulatory credit risk capital. Thus, the calculations of EAD and CCR capital are regulated and overseen by financial supervision authorities.

Currently, banks can use three different methods for calculating EAD, two non-internal methods, the standard method (SM) and current exposure method (CEM) but also a more advanced method called the internal model method (IMM). Using the IMM requires approval from the national financial supervisory authorities. The three models have different levels of complexity and the two non-internal methods, CEM and SM, are significantly simpler than IMM which requires estimation of the exposures future distributions. Both SM and CEM have been comprehensively criticized and since CEM is by far the most used method it will be subject for this study.

In June 2013, the Bank for International Settlements (BIS) published a consultative document where they presented a new non-internal method for calculating EAD [11] (then under the name non-internal model method, or simply NIMM). On the 31st of March 2014 the final version of the new method was published together with the announcement that it will be taken into effect from January 2017 [12]. The final name of the new method is the standardized approach for measuring counterparty credit risk exposures (SA-CCR) and it will replace both SM and CEM for calculating EAD. SA-CCR aims to be more adequate than its predecessors in capturing the risk and also superior in a number of aspects that the old methods have been criticized for. Since the CCR capital significantly affect the overall capital requirement it is important to understand how SA-CCR will change the EAD calculations before it is implemented by European banks. In addition, changing method for calculating EAD will not only affect CCR regulatory capital. EAD is also a parameter, among others, in the calculation of credit valuation adjustment (CVA) regulatory capital as well as the leverage ratio.

3 Purpose

This study seeks to understand how SA-CCR will affect the CCR capital requirement for OTC derivatives in comparison to CEM, which is the most common non-internal method used today. Furthermore, the effects of this new regulation may lead to changes in the optimal portfolio composition due to changes in the costs for holding capital. Thus, this study also aims to investigate how the two methods differ and consequently the EAD values they generate for the portfolios of OTC derivatives. In particular, the study intends to analyze the consequence of the usage of the different approaches for netting as well as the differences in EAD between asset classes. We believe that knowing the potential implications of the new model, before it is enforced, can lead to lower costs at the time for the actual implementation as well as generating competitive advantages for early adaptive institutions.

4 Delimitations

In this study, only OTC derivatives for a single portfolio at a single bank are considered. In addition, a snapshot of the portfolio at a specific time is used for sampling and analysis. Therefore, no variation of EAD over time is considered. The selected portfolio used in this study is just a part of the whole portfolio for a Swedish commercial bank which may not be representative for other institutions. In particular it is a portfolio dominated by institutional counterparties that has been studied. However it can give indications of how SA-CCR can affect EAD for other institutions.

5 Practical implementation

Implementing SA-CCR requires great technical effort and it is not something that can be done overnight, especially not for someone that is not familiar with the systems that are used. Extracting all information that was required to perform the calculations of EAD, which was needed for a comparison of the two methods, was problematic. The data used in this study is extracted directly from the front office system of a Swedish commercial bank which means that the data is not accessible on any public platform. This makes it close to impossible to replicate this study. An alternative approach to the method used in this study would have been to use a completely synthetic portfolio where most of the number where made up. That approach would have been much easier and it would have allowed us to study the technical features of the two methods. However, it would not allow us to draw any conclusions regarding how an implementation of SA-CCR is done in practice using real trades. One of the most important conclusions in this study is that implementing SA-CCR is time consuming and technically demanding since systems are not always set up in a way that makes it easy to access the trade information that is needed. Of course it would have been easier for someone that knows the systems better than someone external. Almost three months of the project time was used to understand and implement the SA-CCR before any results could be generated for analysis. The fact that the final version of SA-CCR was published in late March with a lot of changes made the implementation phase longer than what first was planned for.

6 Report outline

First, in Part II the concept of counterparty credit risk and its different components are mapped out. In addition, the basic concepts of credit risk within regulations are covered. Part III includes short explanations of different derivatives that are included in the study, derivative markets and the concept of risk factors. At the end of this part the reader is also provided with an example portfolio that will be used in the two following parts of the report. In Part IV CEM will be covered and described in detail and in Part V the same is done for SA-CCR. Furthermore, the methodology of the study will be explained in Part VI which is followed by a presentation of the results together with analysis as well as a concluding part with discussion on the implication of these.

Part II
Counterparty Credit Risk

Credit risk is the risk concerned with the losses that can occur if a counterparty defaults. However, one can divide credit risk into two categories: lending risk and CCR which can arise depending on which kind of contract that is considered (see Figure 1). The lending risk is characterized by the fact that the exposure to the counterparty of the contract and thus also the notional amounts are known and static. In addition, lending risk is typically independent from market factors such as interest rates. CCR, on the other hand, is characterized by an uncertainty in the future value of the financial contract and thus also the exposure. Only one counterparty is exposed to lending risk and the risk is thereby unilateral whereas for CCR where both parties can experience exposure throughout the lifetime of the contract which is thereby bilateral. Even though SFTs also generates CCR, it is only CCR for OTC derivatives that will be considered in this study. The basics of the most commonly traded OTC-derivatives and the derivatives that are included in this study will be explained in Section 10. Readers that is not familiar with derivatives are advised to read Section 10 before continuing reading this part.

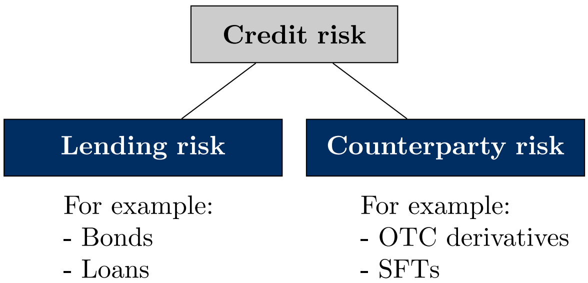

Figure 1: Credit risk

7 Mitigating counterparty credit risk

As with risks in general, financial institutions seeks to reduce or at least mitigate the risks when possible. When it comes to credit risk and CCR there are different ways of reducing the risk. Because CCR is a part of credit risk, methods for mitigating credit risk will also apply for CCR. Gregory [4, p. 41] discusses the main methods for mitigating credit risk. The most obvious way to mitigate credit risk is to adjust the selection of counterparties which will be discussed in Section 7.1. However, the most influential methods that can be used to reduce credit exposure in this context are the usage of netting and collateralization. Both netting and collateralization are incorporated in the EAD calculation and they will therefore be discussed in more detail in Section 7.2 and Section 7.3. Furthermore, details regarding how netting and collateralization are used under CEM and SA-CCR will be discussed in Part IV and Part V respectively.

7.1 Counterparty selection

The most common and simple way of reducing CCR is by adjusting the selection of counterparties. This can include using high-quality counterparties, which are assigned a low probability of default even if the ”too big to fail” now a days is a somewhat antiquated expression. Another way to mitigate CCR is to use so called special purpose entities, where the bankruptcy rules are changed so that, at an event of default, the counterparty can get their payments before other claims to the bankrupt estate are met. Another very important method for mitigating CCR is the usage of central counterparties (CCPs). Strong forces in the financial industry, including regulators through initiatives such as the Dodd Frank act and EMIR, are pushing towards derivatives being traded CCPs [15], like for example NASDAQ OMX Clearing. A CCP works as an inter-connector in the financial market which uses mechanisms such as collateral and netting agreements in combination with economics of scale in order to reduce CCR. Thus, moving derivative trades from the OTC market into the exchanges will extensively lower CCR.

Furthermore, termination events and close-outs where one transaction or all transactions with a specific counterparty can be terminated in the event that some, predetermined, conditions are met. Examples of such conditions are rating downgrade or default.

7.2 Netting

Generally, banks have a range of different contracts, sold as well as bought, with their different counterparties. The basic meaning of netting is that the different exposures that these contracts generate can offset each other and thus reduce the total exposure to this specific counterparty. For this to be allowed a netting agreement (NA) must be established between the two counterparties which will be enforced in the event of bankruptcy by one of the counterparties. Such an agreement can cover all contracts with a counterparty or specific types of contracts. A subset of contracts that are subject for netting is referred to as a netting set. This implies that a number of netting sets can belong to the same counterparty. Thus, the total exposure to a specific counterparty can be described as:

$$Exposure = \sum_{i \notin \{NA\}} max(V_i,0) + \sum_{k} max\Big(\sum_{i \in \{NA_k\}} V_i,\ 0\Big) \tag{1}$$

Where, V_i is the value of contract i and NA_k is netting agreement k. The effect of netting is, as previously mentioned, incorporated in the calculation of EAD.

7.3 Collateral

Collateral refers to securities that are posted by at least one party of the agreement in order to mitigate the credit risk. A collateral agreement can be set up in many different ways. Cash is the most common type of asset used as collateral but real estate or stocks are other examples of assets that can be used as collateral. Collateral is also incorporated in the EAD calculation and mitigates the exposure.

7.3.1 Margin agreements

A margin agreement is related to collateral and a way to further mitigate CCR. This agreement involves counterparties posting collateral over time as the market values of the different contracts, covered by the margin agreement, changes. Thus, it includes a so called variation margin, which is dependent on the value of the contracts and is paid with a predetermined margin period (typically daily, weekly or monthly). Some agreements also include initial margin, where collateral is posted upfront which is usually the case when one counterparty is considered less credit worthy than the other one. Another reason could be that one party has a larger probability to get an exposure than the other one. Posting of collateral may also depend on a predetermined minimum transfer amount (MTA) and a threshold (TH). Here, MTA can be present in order to prevent unnecessarily small transactions and TH determines the level when a counterparty has to start posting collateral.

7.4 ISDA master agreement

Many large banks and institutions in the financial market use standardized agreements for netting and collateral provided by International Swaps and Derivatives Association (ISDA). The agreement specifies the terms and conditions for both parties in an OTC trade. This agreement can also include a margin agreement between the two parties through a so called Credit Support Annex (CSA) that can be added to the ISDA master agreement [19].

8 Counterparty credit risk under Basel regulations

As mentioned, there are regulations provided by BIS that dictate international standards for how banks are to be regulated. One large part is the minimum capital requirement which is stated in the first pillar of Basel II [10]. Here, standards and rules are provided for how this capital is to be calculated. In the context of credit risk there are two different credit risk factors that are considered and that are subject to regulatory capital which are default risk and CVA risk. As the name implies, default risk is concerned with the losses arising from a counterparty defaulting. CVA risk, on the other hand, is the risk arising from volatility in CVA which will be explained briefly in Section 9.1. However, this study will focus solely on the default risk capital and in particular the default risk capital concerned with CCR.

8.1 Default risk

There are a couple of factors that affect the risk a bank is exposed to when considering the default risk. Very simplified it is the current exposure, the probability of the counterparty defaulting as well as the part of this exposure that will be lost in the case of default. Here, Basel II, which currently provides the overall framework for credit risk, has determined that the required default capital for CCR should be calculated as follows:

$$CCR\ regulatory\ capital = 0.08 \cdot EAD \cdot RW \tag{2}$$

The risk weights here aims to adjust the calculated exposure by incorporating factors such as the probability of default mentioned before. Here, Basel II provides two approaches for how to calculate these risk weights, namely:

- **The standardized approach:** The bank calculates minimum required capital using external ratings and bucket charges provided by the Basel committee.
- **The internal ratings based (IRB) approach:** Risk weights are defined as a function of the probability of default (PD), loss given default (LGD), the maturity of the contracts (M) as well as the correlation (ρ) between the assets. The bank can use internal estimates of some parameters (foundation IRB) or all (advanced IRB).

Thus, the choice of approach affects the overall regulatory credit risk capital and thus also the regulatory CCR capital since this is a subset of the credit risk capital. However, this does not affect the calculation of EAD for derivatives, which is considered being independent of the risk weights, as illustrated in (2).

8.2 EAD under Basel Regulations

EAD is always calculated on the netting set level. As mentioned in Section 8.1 EAD is to be calculated in order to determine the regulatory capital a bank must hold. Even if this was touched upon in Section 2 we want to remind the reader about the current methods banks may choose among.

- Current Exposure Method (CEM)
- Standard Method (SM)
- Internal Model Method (IMM)

Recall that the first two methods, CEM and SM, are so called non-internal model methods and does not require supervisory allowance while the IMM does. Thus, it requires modeling the potential future exposure by Monte Carlo simulations. The process of receiving permission to use IMM is costly and therefore only a hand full of banks is using it today. Of the three current models available, the CEM is the most commonly used. SA-CCR is supposed to capture the risk better than its predecessors and be more calibrated with IMM.

As mentioned above, EAD is also used for calculating CVA risk and leverage ratio apart from being used in the calculation for regulatory default credit risk capital. However, only how SA-CCR will affect the latter will be covered in this study.

9 Related risk types

Throughout this study will some other risk types be included in the discussion. Therefore a short explanations of these are provided here.

9.1 CVA risk

EAD is a parameter in the calculation of CVA risk which is therefore closely related to credit risk. As defined by Gregory [4] CVA is an adjustment that is related to the pricing of CCR for a specific contract. Since CVA is incorporated in the balance sheet for a bank, changes in CVA can yield capital losses. CVA risk is therefore related to the volatility of CVA and is also subject to regulation. Banks must hold regulatory CVA capital to cover the CVA risk.

9.2 Wrong-way risk

Wrong-way risk is a concept related to the dependence between the credit quality of a counterparty and the exposure to this counterparty. As Gregory [4] explains, wrong-way risk can be divided into general and specific wrong-way risk. General wrong-way risk will arise when there is a positive dependence between the probability of a counterparty to default and general market risk factors. Specific wrong-way risk arises when the exposure to a specific counterparty has positive dependence with the default probability of that counterparty. No adjustment of EAD is made to reflect wrong-way risk in CEM. BIS has chosen to incorporate the wrong-way risk concept as well as correlations between exposures in SA-CCR by applying the alpha multiplier used in IMM. This multiplier will be discussed in more detail in Part V where SA-CCR is covered.

9.3 Concentration risk

Concentration risk relates to the spread of a bank's exposure among counterparties and the risk this could incur. Neither CEM nor SA-CCR takes concentration risk into consideration. However, concentration risk does effect the bank's overall assessment of capital requirement and is therefore briefly introduced in this study. In Pillar II of Basel II is concentration risk described as "a single exposure or group of exposures with the potential to produce losses large enough to threaten a bank's health or ability to maintain its core operations" [10]. Concentration risk can also concern sector concentration risk and geographical concentration risk. There is no standardized way in how concentration risk should be measured but the model that a bank decides to use must be approved by financial supervision authorities. Even if concentration risk does not affect the minimum capital requirement it can affect the economic capital, which is calculated under Pillar II where the bank is requested to make its own assessment of its risk. The economic capital is as important as the minimum capital requirement and is also a way for banks to ensure their shareholders that the bank stays solvent. Concentration risk is introduced here because the increased allowance of netting benefits under SA-CCR in comparison to CEM might encourage banks to have a large amount of trades with few counterparties rather than fewer trades with many which may lead to increased levels of concentration risk.

9.4 Model risk

Model risk is, as a matter of fact, actually a part of the operational risk field. However, the computation of credit risk by an institution can be under- or overestimated as a result of model risk [14]. Commonly model risk refers to the risk of errors in pricing or hedging but not in this study. Model risk in this context however refers to the risk of estimation errors caused by for example using simulations to estimate future exposure, which is used when calculating EAD under IMM. This concept is introduced here since there is critique towards the different EAD models and the existence of parameters adjusting for model risk. This will be further discussed in the following parts.

Part III
Derivatives and Example Portfolio

Derivatives are financial instruments that are dependent on an underlying variable, and its value is thus also dependent on the value of this underlying variable. This underlying variable can for example be another financial instrument or an exchange rate. There are examples of more exotic derivatives like weather derivatives that, for example, farmers can use to hedge against adverse weather conditions. The list of derivative variants can be very long and derivatives can be used to hedge against almost anything. The derivatives that are used in this study will be shortly introduced in Section 10. Due to the variety and complexity of derivatives they are commonly traded OTC. As mentioned in the introduction, OTC derivatives are not standardized and therefore they are usually not traded over an exchange. However, there are an increasing volume of derivatives that are traded centrally through CCPs as described in Section 7.1. CEM has mainly been developed to handle contracts that are traded OTC whereas SA-CCR in addition to OTC derivatives is supposed to be more suitable for derivatives traded through CCPs. Furthermore, to calculate EAD under SA-CCR it is necessary to determine the primary risk factor for the derivative contract. This can be somewhat difficult since each contract has one or several risk factors. Thus, the concept of risk factors is briefly explained in Section 11. Section 12 will introduce an example portfolio that will be used to make it easier for the reader to understand what is explained in Part IV and Part V where CEM and SA-CCR are presented in detail.

10 Derivative types

To give the reader a better understanding for the derivatives instruments that are included in this study this section explains the features of the instruments briefly. The definitions below are aligned with the definitions by Hull [5].

10.1 Options

An option is a derivative that gives the buyer either the right to buy (call option) or sell (put option) a certain asset at a given price (strike price) at a determined time (exercise date). The options are generally European style or American style which refers to the exercise alternatives of the contract. For a European style option the exercise date is the single date when the buyer can decide if the options should be exercised or not. If the option is of American type it can be exercised at any time before maturity of the contract. There are also option types like Bermudian, a non-standard American option, that is something in between European and American (both in the derivatives context and geographically) with early exercise that is restricted to certain dates. Note that this date affects the time risk horizon for the trade and thus important to have in mind when calculating EAD. In addition, there exists a wide range of exotic options that are more nonstandard. An option does not always have a specific strike price and the strike could also be expressed in terms of a maximum, minimum or barrier of the price for the underlying asset. The strike can also refer to the average price on the underlying asset for a specific time. Some options are forward starting where the options starts at a certain time in the future.

Furthermore, it is important to understand the meaning of the terms in-the-money, at-the-money and out-of-the-money when dealing with options. A call option on a stock is said to be in-the-money when the strike price is lower than the market price for the underlying stock. When the market price for the underlying stock is lower than the strike price is the option said to be out-of-the-money. If the market price for the underlying stock equals the strike price it is said that the option is at-the-money.

10.2 Futures and forwards

Futures and forwards are agreements on selling or buying an asset at a specific rate at a certain time in the future for a price determined today. Futures are in general more standardized than forwards and traded on an exchange. In addition, a future is marked to market on a daily basis and settled using a so called margin account. An example of a forward instrument, which is used in this study, is a so called forward rate agreement where the exchange rate or interest rate for a period of time, starting in the future, is determined today.

10.3 Interest rate specific derivatives

A number of different derivative types arerelated to interest rates. The most common and those that are used in this study will be explained below.

10.3.1 Interest rate swap

An interest rate swap has two legs, one receiving and one paying leg. For a so called plain vanilla interest rate swap is one leg floating while the other leg is fixed. The cash flows for the parties entering the contract are simply swapped so one party pays a fixed rate on principal and receives floating rate on the same principal. A swap can also be constructed with two floating legs which is usually used to hedge between tenors (i.e. point in time). In this case, the swap instrument is usually known as a basis rate swap. Swaps with two floating legs are treated separately in the EAD calculations.

10.3.2 Interest rate cap and floor

An interest rate cap or floor is very similar to a regular interest rate swap but no cash flows are exchanged unless the rate exceeds a predetermined cap or floor level.

10.3.3 Free defined cash flows

Free defined cash flows are usually an IR instrument that is very similar to a swap but the cash flows and the times for cash flows are not standardized.

10.4 Total return swap

A total return swap (TRS) is an agreement where one of the legs of the swap refers to either a fixed or variable rate. The payments on the other leg, on the other hands, refers to the return of an underlying asset. This could, for example, be an index or a bond. Thus, a TRS can belong to different type of asset classes depending on the underlying asset.

10.5 Foreign exchange specific derivatives

Most banks have derivatives in other currencies than the domestic currency. Foreign exchange derivatives can for example be used as hedging instruments for cash flows generated by other activities in the bank.

10.5.1 Foreign exchange swap

In difference to a forward foreign exchange rate agreement with cash flows at one single time, a foreign exchange swap is a swap with cash flows at two points in time. For example, Part A pays X USD to Part B and receives X·S today, where S is the spot exchange rate. At the end of the contract Part A receives X USD and pays X·F, where F is the forward rate.

10.5.2 Currency and cross currency swaps

Both currency and cross currency swaps are very similar to regular interest rate swaps but a currency swap has at least one foreign currency and can for example pay the principal in one currency and interest payments in another currency. The simplest form of currency swaps are fixed to fixed on principals denoted in two different currencies. A variation of currency swaps that are also included in this study are so called cross currency swaps where the swap is defined as float to fixed but still with principal and interest rate payments in two different currencies.

10.6 Credit specific derivatives

10.6.1 Credit default swaps

A credit default swap (CDS) is a contract where the buyer gains protection against a default of a certain entity, like a company or country, on a specific nominal. Hence, the buyer will get the nominal value as defined by the contract in the case of default and in return the seller will gain a premium for taking this risk.

10.6.2 Collateralized debt obligation tranches

A collateralized debt obligation (CDO) is a basket containing debts which are backed with a pool of securities (i.e. collateralized). This basket of debts is then sliced into so called tranches which are based on levels of seniority (i.e. credit worthiness) which are constructed to generate different pay off rates (since they are associated with different levels of credit risk). These tranches are then sold separately as a new instrument with a rating relating to the specific tranche. When CDOs are mentioned as derivatives it usually refers to synthetic CDOs. A synthetic CDO does not require an underlying basket of asset-backed debt but rather refers to the performance of one. Thus, it is more similar to a CDS as defined above. The tranche has an attachment and detachment point which refers to the level of losses of the reference pool. If a tranche for example has an attachment point of 10% and a detachment point of 15% this implies that the tranche is affected when the accumulated losses of the reference pool exceeds 10% of its notional value. When the losses reach the detachment point the tranche has lost its value.

11 Risk factors

There is, as illustrated in the section above, a great variety of derivatives with different behaviors and underlying variables. A derivative can have one risk factors, like 3 months STIBOR for an IR derivative as an example. Other examples of risk factors are spreads between interest rates or the value of a stock. In addition, some derivatives can have two or more risk factors. A cross currency swap is an example of a derivative with two risk factors, an interest rate and a foreign exchange rate. There are also examples of combination instruments that for example can be constructed of a number of options with different underlying variables. Because of the variety of derivatives it is not always straightforward to identify the primary risk factor which SA-CCR requires (see Part V).

12 Portfolio example

In order to help the reader understand the technicalities for the two models an example portfolio will be used to illustrate how the calculations are done in practice. This example portfolio is constructed as follows:

Trade ID	Instrument type	Asset class	MTM Value	Maturity (years)
1	Swaption	IR	45 300	2 + 3
2	IR Swap	IR	230 000	0.5
3	IR Swap	IR	-105 000	4
4	IR Cap	IR	-148 000	10
5	FX Swap	FX	100 000	2
6	FX Swap	FX	-20 000	3
7	Currency swap	FX	15 000	8
8	Stock option	EQ	5 000	1
9	Index option	EQ	-123 000	1
10	CDS	CR	-7 000	10
11	Commodity option	CO	38 000	2 & 4

Table 1: The example portfolio

Here, the maturity 2 + 3 implies that the swap starts on the exercise date of the option and 2 & 4 implies that the underlying commodity future is active and matures in 4 years. Furthermore, all trades in the portfolio above belongs to one counterparty. This counterparty has a netting set that includes all IR, FX and EQ trades. Therefore, the counterparty will in total have three netting sets where the credit derivative and commodity derivative trades will belong to separate single trade netting sets. For the large netting set, the counterparty has posted 100 000 SEK in collateral to our bank. However, the counterparty has no margin agreement. The concept and implication of this will be further explained in following parts.

Part IV
Current Exposure Method

The model CEM for measuring CCR in off balance sheet derivatives was already introduced in 1988 in the Basel I Accord [8]. Even though SM was introduced in Basel II, CEM is still the most used method for banks that have not got approval for using IMM. Naturally, CEM has been somewhat developed throughout the years in order to adapt to new market conditions and it is described fully in Basel II [10]. However, the main structure of the method is the same as it was back in 1988 and when using CEM, the bank has to determine their current exposure by using the mark-to-market (MTM) values of the contracts and an add-on which reflects the potential future changes in these values. Under CEM, EAD is thus defined as:

$$EAD_{CEM} = RC_{CEM} + AddOn \tag{3}$$

The Replacement Cost (RC) is a parameter that aims to reflect the cost of replacing the position if the counterparty was to default today and is further defined as:

$$RC_{CEM} = max(V - C, 0) \tag{4}$$

Here, V represents the MTM value of the exposure of the netting set which is then reduced by the collateral amount if the netting set and its transactions are subject to a collateral agreement. Thus, if a netting agreement is applicable are the positions within this netting set allowed to offset when aggregated. Otherwise each trade is treated as a separate netting set. In addition, the collateral can be subject to an adjustment, a so called haircut, which is further explained in Section 14. Naturally, as relation (4) shows, the exposure is not allowed to be considered negative. Furthermore, an add-on is applied to account for a potential change in the credit exposure in the future.

Note that banks are also allowed to recognize collateral in the calculation of the RWs that are multiplied with EAD. This depends on if the bank uses the simple or comprehensive approach for its collateral. When the simple approach is used, recognition of collateral in the RWs is allowed. In this case, collateral is not included in the RC calculation as in (4) above. However, in this study, the comprehensive approach will be used. An example of how the replacement cost is calculated for the example portfolio is given below.

Example: Replacement cost under CEM

For the example portfolio we have that trade 1 to 7 are subject to a netting agreement and is therefore considered as a netting set (NS). As mentioned, this netting set is also subject to a collateral agreement (which is assumed not to be subject to any haircuts). Thus, given the MTM values in Table 1, we have the following RC for our netting set:

$$\begin{aligned} RC_{NS} &= max\Big(\sum_{i \in [1,7]} V_i \; - \; C \; , \; 0 \Big) \\ &= max\Big(-700 - 100\,000 \; , \; 0 \Big) = 0 \; SEK \end{aligned}$$

For trade 8 and 9, that are not subject to any netting or collateral agreements, we get that the replacement costs are $RC_8 = max(-7\,000,0) = 0$ SEK and $RC_9 = max(38\,000,0) = 38\,000$ SEK respectively.

13 Add-on calculation

The add-on, under CEM, is supposed to reflect the potential change of exposure and thus the volatility in the value of the trade. In CEM, the add-on is first calculated on a trade level and is, for a specific trade i, defined as:

$$AddOn_i = AddOnFactor_i \cdot N_i \tag{5}$$

Here, N_i is the notional amount of the trade and $AddOnFactor_i$ is a supervisory parameter which is predetermined and provided by the Basel committee. The $AddOnFactor_i$ is dependent on the remaining maturity of the trade and which asset class the trade belongs to. The add-on factors and the conditions are shown in Table 2 and the definition of notional amounts are explained in the next example.

Residual maturity	< 1 year	> 1 year or < 5 years	> 5 years
IR	0.0 %	0.5%	1.5%
FX and gold	1.0%	5.0%	7.5%
EQ	6.0%	8.0%	10.0%
Precious Metals (excl. gold)	7.0%	7.0%	10.0%
Other CO	10.0%	12.0%	15.0%

Table 2: Add-on factors from Basel II

The add-on factors for credit derivatives are not included in Table 2 since the add-on factors for this asset class are not dependent on the remaining maturity. Under CEM are credit derivatives categorized as either total return swaps or credit default swaps and the add-on factors for single name derivatives are 5% if it is a ”qualifying” reference obligation and 10% if it is a ”non-qualifying” reference obligation for both instrument types. This relation is shown in Table 3 below.

	Protection buyer	**Protection seller**
Total Return Swap		
”Qualifying” reference obligation	5%	5%
”Non-qualifying” reference obligation	10%	10%
Credit Default Swap		
”Qualifying” reference obligation	5%	5%*
”Non-qualifying” reference obligation	10%	10%*

* The protection seller of a CDS is only be subject to the add-on factor where it is subject to closeout upon the insolvency of the protection buyer while the underlying is still solvent. Add-on should then be capped to the amount of unpaid premiums

Table 3: Add-on factors for CR derivatives

Thus, the add-on factors apply both for the protection seller and the protection buyer. Furthermore, if the derivative refers to a basket of index linked items, the item with lowest rating will determine the add-on factor. If any item is a "non-qualifying" reference obligation the add-on for that category should be used for the whole basket. Details about which type of securities that are included in the qualifying category can be found in Basel II [10]

Example: Calculation of notional amount

The first step when calculating the add-on is to determine the notional amount of the trade. This can be simple and intuitive but also less obvious for some instruments. Here, we will explain how notional amount is defined under CEM for the different instruments in our example portfolio. Note that this is the same notional amount that is used initially in SA-CCR.

Notional amount for IR and CR derivatives
For the IR and CR trades in the example portfolio the notional amount is somewhat intuitive since it is the nominal given within the definition of the trade. For the swaption, the notional amount is given by the nominal of the underlying swap. Thus, for the example portfolio we have:

Nr	Instrument	Nominal	Currency
1	Swaption	5 000 000	SEK
2	IR swap	3 000 000	SEK
3	IR swap	500 000	EUR
4	IR cap	1 000 000	SEK
11	CDS	800 000	SEK

However, in order to get the notional amount for trade 3 that is to be used in the add-on calculation under CEM it must first be converted into SEK. Given that the exchange rate EUR/SEK is 9.0 we get that the notional amount, $N_3 = 500000 \cdot 9.0 =$ 4 500 000 SEK.

Notional amount for FX derivatives
In similarity to IR derivatives, the notional amounts for the FX derivatives in our portfolio are also intuitive and given by the definition. However, the notional amounts need to be converted into the domestic currency. For the FX trades in our example portfolio we have the properties shown in the table below.

Nr	Instrument	Nominal	Currency pair
5	FX Swap	1 000 000	SEK/EUR
6	FX Swap	100 000	EUR/SEK
7	Currency Swap	500 000	USD/SEK

Here, in the first FX swap (trade 5) we have entered a contract where we at the end will receive 1 000 000 SEK and pay 1 000 000 $\cdot R_5^{forward}$ EUR. Thus, given that the spot exchange rate EUR/SEK = 9.0 and the forward rate (SEK/EUR) $R_5^{forward} = 0.1$, the FX leg converted into SEK is gives us a notional amount of $N_5 = 1\,000\,000 \cdot 0.1 \cdot 9.0 = 900\,000$ SEK.

In the second swap (trade 6) the relation is reverted and we receive 100 000 EUR and pay 100 000 $\cdot R_6^{forward}$ SEK at the end of the contract. Thus, the notional amount is $N_6 = 100000 \cdot 9.0 = 900000$ SEK (given the same spot rate as above).

Similarly for the currency swap (trade 7) we have, given that the spot exchange rate USD/SEK = 6.5, a notional amount of, $N_7 = 500\,000 \cdot 6.5 = 3\,250\,000$ SEK.

Notional amount for EQ and CO derivatives
For EQ and CO derivatives the notional amount is defined as the number of units

referenced by trade multiplied with the current price. Thus we the notional amounts shown in the table below.

Nr	Instrument	Nr of units	Current price (SEK)	Notional amount
8	Stock option	800	125	100 000
9	Index option	1500	1 350	2 025 000
11	Commodity option	600	850	510 000

When aggregating the add-ons for a netting set some benefits of netting between the add-ons are recognized and the aggregated add-on in (3) for the netting set is thus defined as:

$$AddOn = 0.4 \cdot AddOn_{Gross} + 0.6 \cdot NGR \cdot AddOn_{Gross} \tag{6}$$

Where,

$$AddOn_{Gross} = \sum_i AddOn_i \tag{7}$$

Here, NGR is short for net gross ratio and is the fraction of net exposure and the level of gross exposure for the transactions in the netting set. Thus, NGR will have a mitigating effect on the add-on to reflect the positive aspects of netting and is hence defined as follows:

$$NGR = \frac{max(\sum_i V_i,0)}{\sum_i max(V_i,0)} \tag{8}$$

However, it is important to note that, due to the relation in (6), CEM only allows recognition of netting up to 60%.

Example: Add-on calculations under CEM

When calculating the add-on we start with calculating the trade level, $AddOn_i$, for each trade. Hence, we multiply the notional amount with the corresponding add-on factor. We then get the add-on's as shown in the following table.

Nr	Instrument	Notional amount	Res. mat	AddOnFactor	$AddOn_i$
1	Swaption	5 000 000	2	0.5%	25 000
2	IR swap	3 000 000	0.5	0.0%	0
3	IR swap	3 250 000	4	0.5%	16 250
4	IR cap	1 000 000	10	1.5%	15 000
5	FX Swap	900 000	2	5.0%	45 000
6	FX Swap	900 000	3	5.0%	45 000
7	Currency Swap	3 250 000	8	7.5%	243 750
8	Stock option	100 000	1	8.0%	8 000
9	Index option	2 025 000	1	8.0%	162 000
10	CDS	800 000	10	10.0%	80 000
11	Commodity option	510 000	2	15.0%	61 200

Note that for trade 10 and 11 which are not subject to a netting agreement the add-ons above are also the final add-ons. Moreover, the gross add-on for the netting set is equal to:

$$AddOn_{Gross} = \sum_{i=1}^{9} AddOn_i = 25\,000 + ... + 162\,000 = 560\,000 \text{ SEK}$$

Now, we need to calculate NGR for the netting set. We know from previous examples that the sum of MTM-values is negative which leads to the numerator in the NGR being equal to zero which leads to a NGR of 0 as well and we get the following calculation for the total add-on:

$$AddOn = 0.4 \cdot 560\,000 + 0.6 \cdot 0 \cdot 560\,000 = 224\,000 \text{ SEK}$$

14 Collateral and haircuts

A haircut is a factor multiplied with the collateral amount to reflect the probability of a change in the value of the collateral which is used under the comprehensive approach as defined under Basel II [10]. This could be due to changes in market risk factors such as interest rate or foreign exchange rate depending on what type of collateral that is used. A certain type of collateral is thus assigned a predetermined haircut factor depending on the characteristics of the security.

A bank has two options when calculating haircuts. The bank could use the supervisory haircuts provided by the Basel Committee or calculate the haircuts on their own. A bank is only permitted to calculate their own haircuts under condition that they fulfill a number of quantitative and qualitative requirements. In addition to standard and own-estimated haircuts, a bank can be permitted to use a Value at Risk approach to calculate the haircuts for so called repo-style transactions. More information about the details of haircuts can be found in Basel II [10].

However, it is important to mention that there is no difference in the calculation of haircuts between CEM and SA-CCR.

15 Critique towards CEM

The main critique concerning CEM, from the industry as well as BIS itself, is that it does not capture the risk in an adequate way [7, 11]. For example, CEM does not compensate for potential wrong way risk. This lack of adequacy in capturing the risk is most recognized in periods of financial stress. This is, to a large extent, because the supervisory add-on factors are static and do not satisfactory capture the level of volatility observed in recent financial crises. That is why a model, better calibrated with stressed periods, has been demanded. The fact that CEM is simplistic and the add-ons are conservative but do not capture the risk in a compelling way has been the main arguments for developing a new non-internal method.

CEM has also been criticized for not fully recognizing the benefits of netting and excess collateral. Under CEM, the recognition of netting benefits in the add-on calculation is limited to a maximum of 60%. This is considered crucial since the add-on generally contributes significantly more to the total EAD than RC. In SA-CCR the intention is that netting benefits should be recognized to a higher extent. In addition, there is no mitigating effect of negative market values on the add-on under CEM which has also been criticized.

CEM does not differentiate between margined and unmargined transaction. Margin agreements significantly lower exposure which should be reflected in the calculations of minimum capital requirements. This shortcoming has been taken in to consideration when developing the new model and SA-CCR takes margin agreements in to account in the calculation of EAD.

Furthermore, CEM was not constructed for usage of calculating EAD for CCPs which is now a concern under Basel III [13] where banks are required to calculate their EAD not only for OTC derivatives but for centrally cleared trades as well. Thus, a model that is better adapted to this new regulation requirement has also been demanded.

Consequently, there is no doubt that developing a new non-internal method is a great challenge. This challenge is acknowledged both by the industry and regulators. This since the measure must adequately reflect the risk both in times of economic stability and during stressed periods. In addition, there are unwanted consequences both with a model that overestimates risk as well as one that underestimates it. Thus, developing a model that is not too complex but still captures the risk is not an easy task.

Part V
Standardized Approach

All the technical details for calculation of EAD under SA-CCR can be found in the document published by BIS in March 2014 [12]. This part will go through all the required steps and technical details that are needed for calculation of EAD under SA-CCR and to generate the results for this study. Practical examples will be presented where calculations are performed on the example portfolio introduced in Section 12

The definition of EAD under SA-CCR is somewhat similar to CEM where it is defined as the sum of the RC and an add-on (here called potential future exposure (PFE)). Here, the EAD is defined as:

$$EAD_{SA-CCR} = \alpha \cdot (RC + PFE) \tag{9}$$

The α multiplier here is set by the Basel committee and is defined in the same way as for the more advanced IMM and is thus 1.4. This scale factor is there used in order to somewhat adjust for the potential wrong way risk and model risk (described in Section 9). Here, RC and PFE are both calculated on a netting set level, where netting sets are applicable. In addition to what is said about netting sets in Section 7.2, a netting set can have multiple margin agreements connected to it. In that case the netting set has to be divided into sub-netting set that are treated separately, one for each agreement. To meet the critique towards CEM regarding risk sensitiveness, SA-CCR has been created with more details to better capture the risk. The parameters are also calibrated to stressed periods to perform better in bad financial market conditions.

16 Replacement cost

RC, sometimes referred to as the current exposure, is basically the cost of replacing the position if the counterparty in question was to default today. As mentioned, RC is calculated on a net setting level. Given that there is no collateral agreement; RC is the MTM value of the derivative. However, most of the OTC derivatives traded today (90% as the end of 2013 [18]) include some type of collateral agreement and when these are present the picture becomes somewhat more complex (see Figure 2).

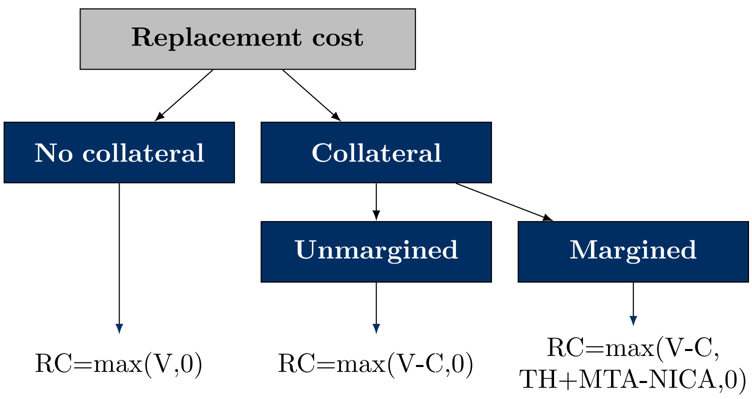

Figure 2: Replacement cost under SA-CCR

In difference to CEM, SA-CCR makes a difference between margined and unmargined transactions. For an unmargined transaction RC is basically the MTM value, V, reduced by the collateral posted to the bank. As under CEM, RC is always floored by zero, i.e. you cannot account for over-collateralization and get a negative RC. The collateral value, C, is a haircut value of the collateral held, as in CEM if the comprehensive approach is used. However, the presence of a margin agreement yields a RC that is the maximum of V-C (here C is the collateral balance generated by previous variation margin payments) and the largest exposure that would not trigger a collateral call. The largest exposure that would not trigger a collateral call is represented by the threshold (TH) plus the minimum transfer amount (MTA) reduced by the, so called net independent collateral amount (NICA). Hence, TH + MTA represents the level at which a collateral transaction will take place. Furthermore, NICA is defined as:

$$NICA = ICA_{posted\ to\ the\ bank} - ICA_{posted\ by\ the\ bank\ (unsegregated)} \tag{10}$$

Here, ICA is the independent collateral amount which is defined as any collateral posted except for the variation margin. Thus, NICA reflects the net amount between the parties except for the segregated collateral that is posted by the bank through a so called remote bankruptcy account.

Example: Replacement cost under SA-CCR

For the example portfolio and its netting sets we have no margin agreement. Thus, RC will be the same as for CEM, i.e. zero for the netting set as presented in the example in Section IV. The same goes for trade 8 and 9, without netting agreement, which has a RC of 0 SEK and 38 000 SEK respectively.

17 Potential future exposure

The PFE is the factor that accounts for uncertainties in the future value of the contracts and is in that sense similar to the add-on in the CEM. Thus, it is present in order to adjust for the volatility in exposure. Here, the PFE for a netting set is defined as:

$$PFE = multiplier \cdot AddOn^{aggregate} \tag{11}$$

Here, the multiplier is present in order to account for potential over-collateralization and thus reducing the minimum capital requirement. This will be further explained in Section 17.3. The aggregated add-on is, in similarity to CEM, a function of the add-on for different asset classes. Here, no offset between asset classes is allowed and the aggregated add-on is defined as:

$$AddOn^{aggregate} = \sum_a AddOn^a \tag{12}$$

The method of calculating the adjusted add-on, $AddOn^a$ is different depending on the asset class, a. Furthermore, the calculation within each asset class is dependent on another categorization which is called hedging sets. Within and between these hedging sets different types of offset are allowed. Thus, this is done in order to recognize some of the netting benefits also in the add-on and the purpose is similar to the one of NGR (8) used in the CEM. However, the netting within hedging sets is supposed to recognize the benefits of netting better and more accurately than NGR in CEM. The definitions used for these hedging sets is presented in Table 4 together with the rules of offsetting.

Asset Class	Definition of heding set	Offsetting
IR	Consists of derivatives with the same currency.	Positions within hedging sets are allowed to offset each other within maturity categories, otherwise partial or no offsetting.
FX	Consists of derivatives with the same currency pair.	Positions within hedging sets are allowed to perfectly offset.
CR & EQ	One hedging set for equity derivatives and one for credit derivatives.	Partial offsetting between positions.
CO	Four hedging sets: energy, metals, agricultural and other.	Partial offsetting between positions.

Table 4: Categorization of hedging sets

In addition to the definition of hedging sets above there are two special cases:

- Basis transactions: Derivatives which value depends on two risk factors and the spread between them in one single currency.
- Volatility transactions: Derivatives whose value depends on the volatility of a risk factor.

All basis transactions and volatility transactions must be treated in separate hedging sets and the supervisory factor is multiplied with 0.5 and 5 respectively. The supervisory factors are further explained in the section below.

17.1 Mutual add-on parameters

As mentioned, the calculation for add-ons differs between asset classes. However, they have some parameters in common such as a supervisory delta adjustment, δ, and a supervisory factor (SF). These, together with the trade level adjusted notional amount, d_i (which is somewhat defined differently depending on asset class), are used and calculated on a trade level. Furthermore, a supervisory correlation, ρ, is defined on the hedging set level which is used for the add-on calculations for some of the asset classes. The add-on calculations for the respective asset classes and how these parameters are incorporated are further explained in Section 17.2.

17.1.1 Supervisory delta adjustment δ

This parameter is used on the trade level in order to account for direction of different trades when the underlying variable is changed. This parameter is thus multiplied with the trade level adjusted notional amount, d_i, and the values of these parameters are shown in Table 5. The supervisory delta adjustment is closely related to the delta risk measure. When delta is referred to as a risk measure it is defined as the first derivative of the value of the contract with respect the underlying risk factor (i.e. interest rate, price of commodity etc.). The delta adjustment for options will also reflect if the option is out-of-the money, in-the-money or at-the-money.

Delta value	Instruments
$\delta_i = +1$	Instruments that are not options or CDO tranches and are long in their primary risk factor
$\delta_i = -1$	Instruments that are not options or CDO tranches and are short in their primary risk factor
$\delta_i = +\Phi(q_i)$ *	Bought Call Options
$\delta_i = -\Phi(q_i)$ *	Sold Call Options
$\delta_i = \Phi(-q_i)$ *	Bought Put Options
$\delta_i = -\Phi(-q_i)$ *	Sold Put Options
$\delta_i = +\frac{15}{(1+14 \cdot A_i)\cdot(1+14 \cdot D_i)}$ **	Purchased CDO tranche
$\delta_i = -\frac{15}{(1+14 \cdot A_i)\cdot(1+14 \cdot D_i)}$ **	Sold CDO tranche

* $q_i = \frac{ln(P_i/K_i)+0.5 \cdot \sigma_i^2 \cdot T_i}{\sigma_i^2 \cdot \sqrt{T_i}}$, where P_i = underlying price, K_i = strike price and T_i = latest contractual exercise date, σ_i = supervisory volatility
** A_i = attachment point, D_i = detachment point

Table 5: Supervisory delta adjustment

Note that for options, a supervisory volatility is included as well. These are determined by the Basel Committee and can be found in Table 6.

Asset Class	Volatility
IR	50%
FX	13%
CR, Single name	100%
CR, Index	80%
EQ, Single Name	120%
EQ, Index	75%
CO, Electricity	150%
CO, Other	70%

Table 6: Supervisory volatility

Example: Delta calculation

Delta calculation for IR derivatives (excl. options)
Naturally, the primary risk factor for IR derivatives is the floating rates that the different contracts refer to. Thus, for swaps and swap-like contracts the risk factor is related to the floating leg. For the derivatives in our portfolio we have the relation shown in the table below.

Nr	Instrument	Recieving	Paying	δ_i
2	IR Swap	Fixed	Floating	-1
3	IR Swap	Floating	Fixed	1
4	IR Cap	Floating above cap	-	1

Here, $\delta_2 = -1$ since the market value of the swap would go down if the market rate goes up. The reverse is true for trade 3. For trade 4 which is an IR cap, delta works somewhat different where protection is bought towards the rate going up. Thus, the value of this contract goes up when the rate does, so $\delta_i = 1$.

Delta calculation for FX derivatives
For the FX related swaps in the example portfolio the risk factors are given by the exchange rates that define the hedging sets. Thus we have:

Nr	Instrument	Recieving	Paying	Risk factor	δ_i
2	FX Swap	EUR	SEK	EUR/SEK	-1
3	FX Swap	SEK	EUR	EUR/SEK	1
4	Currency swap	SEK	USD	USD/SEK	1

Delta calculation for CR derivatives
For the CDS in our portfolio protection is bought for a bond issued by Country X. Thus, the value of the contract depends on the credit rating of this country. Hence, the value of the contract will decrease as the credit rating gets higher and thus $\delta_{10} = -1$.

Delta calculation for options
Now, we consider the option contracts in our portfolio. These are shown in the table below together with the information that is needed to determine delta. Note that the numbers below are for one unit, whereas the trades might refer to more.

Nr	Instrument	Option type	K_i	T_i	P_i
1	Swaption	Bought call option	50 000	2	51 000
8	Stock option	Bought put option	120	1	125
9	Index option	Sold call option	1 400	1	1 350
11	Commodity option	Bought call option	800	2	850

Using the strike price K_i, latest contractual exercise date T_i and current spot price P_i together with the supervisory volatilities σ_i given in Table 6 we can now calculate q_i as given in Table 5.

$$
\begin{aligned}
q_1 &= \tfrac{ln(51\,000/50\,000)+0.5\cdot 50\%\cdot 2}{50^2\%\cdot\sqrt{2}} \simeq 1.47 \\
q_8 &= \tfrac{ln(125/120)+0.5\cdot 120\%\cdot 1}{120^2\%\cdot\sqrt{1}} \simeq 0.45 \\
q_9 &= \tfrac{ln(1\,350/1\,400)+0.5\cdot 75\%\cdot 1}{75^2\%\cdot\sqrt{1}} \simeq 0.60 \\
q_{11} &= \tfrac{ln(850/800)+0.5\cdot 70\%\cdot 2}{70^2\%\cdot\sqrt{2}} \simeq 1.10
\end{aligned}
$$

Now, the delta can be calculated using the probability density function Φ for the standard normal distribution.

$$
\begin{aligned}
\delta_1 &= \Phi(1.47) \simeq 0.93 \\
\delta_8 &= \Phi(-0.45) \simeq 0.33 \\
\delta_9 &= -\Phi(0.60) \simeq -0.73 \\
\delta_{11} &= \Phi(1.10) \simeq 0.86
\end{aligned}
$$

17.1.2 Supervisory factor SF_i

The supervisory factor is multiplied with add-on for the different hedging sets (or entity or type depending on asset class). This is done in order to account for the specific volatility of the trades within different asset classes/hedging sets. Thus, this parameter is similar to the add-on factor in the CEM calculation. These supervisory factors are to be determined by the national supervisors with some guide-lines from the Basel committee. The initial proposal by the Basel committee is presented in Table 7. Note that the different types for which CO derivatives are categorized are not final and BIS have proposed that these are for national supervisory authorities to decide on.

Asset Class	**Type/HS**	**Subclass**	**SF**
IR	-	-	0.50%
FX	-	-	0.50%
CR	Single Name	AAA	0.38%
		AA	0.38%
		A	0.42%
		BBB	0.54%
		BB	1.06%
		B	1.6%
		CCC	6.00%
	Index	IG	0.38%
		SG	1.06%
EQ	Single Name	-	32.0%
	Index	-	20.0%
CO	Energy	Electricity	40.0%
		Oil/Gas	20.0%
	Metals	-	18.0%
	Agricultural	-	18.0%
	Other	-	18.0%

Table 7: Supervisory factors

17.1.3 Supervisory correlation parameter ρ_i

When calculating the add-on for the credit, equity and commodity asset classes a correlation parameters ρ_i is used when aggregating calculations within different asset classes or hedging set (depending on the rules for that specific asset class). These correlation parameters are derived from a single factor model and defines the weight between the syncratic and idiosyncratic component described in Section 17.2.3. The correlations that are used are shown in Table 8.

Asset Class	Correlation
IR	N/A
FX	N/A
CR, Single name	50%
CR, Index	80%
EQ, Single name	50%
EQ, Index	80%
CO	40%

Table 8: Supervisory correlations

17.1.4 Time periods, dates and risk horizon

A number of time parameters are used in the calculations that are performed on the hedging set level as well as on the trade level. Thus, these will be shortly introduced and explained to prepare the reader for what is coming next. In SA-CCR three main dates appear and these are presented in Table 9.

Time parameter	Definition
Maturity M_i	Latest date when the contract is still active.
Start Date S_i	Start date of the time period referenced by an interest rate or credit contract.
End Date E_i	End date of the time period referenced by an interest rate or credit contract.

Table 9: Time parameters

Thus, the maturity, M_i, is extracted from all trades whereas S_i and E_i are only estimated for credit and interest rate trades. Here, M_i is the latest date when the contract may still be active. Hence, if the contract has an underlying instrument that is also a derivative and it is physically settled, M_i will relate to the settlement date of the underlying instrument. The maturity M_i, then floored by ten days, is also used for calculating the maturity factor, MF_i, described in Section 17.1.6.

The start date S_i is thus the referenced start date of a credit or interest rate contract and is therefore often zero if the contract is not forward starting. However, if the contract has an underlying instrument that is a credit or interest rate instrument S_i will be given by the start date of the underlying instrument.

Furthermore, E_i is the end date of a credit or interest rate contract. If the derivative has an underlying instrument that is another credit or interest rate instrument, E_i will refer to the latest date when the underlying instrument may still be active (no matter if it is physically settled or not).

Example: Determining date parameters

The time parameters for the example portfolio are shown in the table below. Note that the start date S_i and end date E_i are only determined for IR and CR related trades.

Nr	AC	Instrument	Information	M_i	S_i	E_i
1	IR	Swaption	Cash-settled 2 year option on 5 year swap	2 years	2 years	7 years
2	IR	IR Swap	Matures in 0.5 year	0.5 year	0	0.5 year
3	IR	IR Swap	Matures in 10 years	4 years	0	4 years
4	IR	IR Cap	Matures in 4 years	10 years	0	10 years
5	FX	FX Swap	Matures in 2 years	2 years	-	-
6	FX	FX Swap	Matures in 3 years	3 years	-	-
7	FX	Currency swap	Matures in 8 years	8 years	-	-
8	EQ	Stock option	Cash-settled 1 year option	1 years	-	-
9	EQ	Index option	Physically-settled 1 year option	1 years	-	-
10	CR	Index CDS	Matures in 10 years	10 years	0	10 years
11	CO	Commodity option	Physically-settled 2 year option on 4 year crude oil future	4 years	-	-

17.1.5 Supervisory duration

For IR and CR derivatives the supervisory duration, SD_i, will be used in the add-on calculation and is defined as:

$$SD_i = \frac{exp(-0.05 \cdot S_i) - exp(-0.05 \cdot E_i)}{0.05} \tag{13}$$

Thus, the values of SD_i are related to the remaining maturity to the end date E_i reduced by the start date S_i. Examples of which values SD_i can take are given in the example below.

Example: Supervisory duration calculation

In the example portfolio we have five trades that are classified as IR and CR derivatives. These are shown in the table below together with the start date S_i and end date E_i determined in the previous example.

Nr	AC	Instrument	S_i	E_i
1	IR	Swaption	2 years	7 years
2	IR	IR Swap	0	0.5 year
3	IR	IR Swap	0	4 years
4	IR	IR Cap	0	10 years
10	CR	Index CDS	0	10 years

Thus, by using the dates above we can now calculate the respective supervisory duration parameters as follows:

$$SD_1 = \frac{exp(-0.05 \cdot 2) - exp(-0.05 \cdot 7)}{0.05} \simeq 4.00$$

$$SD_2 = \frac{exp(-0.05 \cdot 0) - exp(-0.05 \cdot 0.5)}{0.05} \simeq 0.49$$

$$SD_3 = \frac{exp(-0.05 \cdot 0) - exp(-0.05 \cdot 4)}{0.05} \simeq 3.63$$

$$SD_4 = SD_{10} = \frac{exp(-0.05 \cdot 0) - exp(-0.05 \cdot 10)}{0.05} \simeq 7.87$$

17.1.6 Maturity factor

For all asset classes, the add-on calculation will include a parameter called maturity factor, MF_i. This parameter is included to reflect the time risk horizon and is defined as:

$$MF_i = \sqrt{\frac{min(M_i{,}1\ year)}{1\ year}} \tag{14}$$

for unmargined transactions (here,M_i is floored by 10 days), and

$$MF_i = \frac{3}{2}\sqrt{\frac{MPOR}{1\ year}} \tag{15}$$

for margined transactions. MPOR is the margin period of risk which is the actual time it takes to receive collateral and is defined as:

$$MPOR = F + N - 1 \tag{16}$$

Here, N is the re-margining period and F is the supervisory floor generally defined as follows:

- A minimum of 10 days for OTC transactions subject to daily margining
- 5 days for centrally cleared derivatives (also subject to daily margining)
- 20 days for netting sets containing more than 5000 OTC trades

The definition of MF_i makes SA-CCR differentiate even more between margined and unmargined transactions.

Example: Supervisory duration calculation

The example portfolio has one netting set (for trade 1-7). However, this is not subject to a margin agreement. Thus, the maturity factor MF_i will be calculated similarly for all trades in the portfolio. Note that, since the transactions are unmargined, M is floored by 10 days (even if this will not affect our maturities). Thus, for trade 1 we get the following maturity factor:

$$MF_1 = \sqrt{\tfrac{min(2,1)}{1}} = 1$$

The same calculation can then be made for all trades which leads to the resulting maturity factors shown below (rounded to one decimal):

Nr	Instrument	M_i	MF_i
1	Swaption	2 years	1.0
2	IR Swap	0.5 year	0.7
3	IR Swap	4 years	1.0
4	IR Cap	10 years	1.0
5	FX Swap	2 years	1.0
6	FX Swap	3 years	1.0
7	Currency swap	8 years	1.0
8	Stock option	1 years	1.0
9	Index option	1 years	1.0
10	Index CDS	10 years	1.0
11	Commodity option	4 years	1.0

As can be observed in the table above as well as by the definition, the maturity factor will work as a mitigating factor for trades with maturity less than one year (and generates no effect for the other trades).

17.2 Hedging set calculations

17.2.1 Calculations for IR hedging sets

For IR derivatives the hedging sets are, as shown in Table 4, defined by the traded currency. Furthermore, no offset is allowed across different hedging sets. Thus, the add-on factor for IR derivatives is defined as follows:

$$AddOn^{IR} = \sum_j AddOn^{IR}_{HS_j} \tag{17}$$

$$AddOn^{IR}_{HS_j} = SF^{IR}_j \cdot EN^{IR}_j \tag{18}$$

Here j is the currency (i.e. referring to a specific hedging sets) and EN^{IR}_j is the effective notional amount, which is an aggregated sum of the effective notional amounts within three predetermined maturity buckets in the hedging set. These maturity buckets are: less than 1 year, between 1-5 years and more than 5 years. Aggregation between these buckets allows for partial offsetting and the effective notional amount is defined as follows:

$$EN^{IR}_j = \sqrt{(D^{IR}_{j1})^2 + (D^{IR}_{j2})^2 + (D^{IR}_{j3})^2 + 1.4D^{IR}_{j1}D^{IR}_{j2} + 1.4D^{IR}_{j2}D^{IR}_{32} + 0.6D^{IR}_{j1}D^{IR}_{j3}} \tag{19}$$

Here, a correlation of 0.7 is assumed between the buckets close in time and 0.3 between bucket 1 and 3 which are more separated with respect to time. However, banks can choose not to recognize offsetting benefits across maturity buckets. In that case the aggregation is done as follows:

$$EN^{IR}_j = |D^{IR}_{j1}| + |D^{IR}_{j2}| + |D^{IR}_{j3}| \tag{20}$$

In the equations above, D^{IR}_{jk} is the effective notional amount for maturity bucket k and is further defined as:

$$D^{IR}_{jk} = \sum_{i \in HS_j, Bucket_k} \delta_i \cdot d^{IR}_i \cdot MF_i \tag{21}$$

Here d^{IR}_i, the trade level adjusted notional amount of contract i, is defined as the product of the trade notional amount converted to domestic currency and multiplied with supervisory duration SD_i. This adjusted notional amount is then multiplied by δ_i and MF_i in order to recognize direction as well as adjusting for maturity. As mentioned, δ_i also reflects if an option is in-the-money or out-of-the-money.

Example: IR hedging set calculation

For the example portfolio we have trade 1 to 4 that are classified as interest IR. The information that is needed to calculate the add-on for these trades is provided in the table below. Note that the bucket, k, is given by the end date E_i.

Nr	Instrument	Notional amount	HS	k	SD_i	MF_i	δ_i
1	Swaption	5 000 000	SEK	3	4.00	1.00	0.93
2	IR Swap	3 000 000	SEK	1	0.49	0.71	-1
3	IR Swap	4 500 000	EUR	2	3.63	1.00	1
4	IR Cap	1 000 000	SEK	3	7.87	1.00	1

Step 1 is to calculate the trade level adjusted notional amount, d_i for the trades. Recall that this is defined as $d_i = N_i \cdot SD_i$ for IR derivatives and that the notional amount N_i must be converted to the domestic currency. Here, we assume that the notional amount for trade 3 above is already converted into SEK. Thus, we get:

$$d_1 = 5\,000\,000 \cdot 4.00 = 20\,000\,000 \;,\; d_2 = 3\,000\,000 \cdot 0.49 = 1\,470\,000$$
$$d_3 = 4\,500\,000 \cdot 3.63 = 16\,335\,000 \;,\; d_4 = 1\,000\,000 \cdot 7.87 = 7\,870\,000$$

Now, the effective notional amount for the buckets, $D_{j,k}$, can be calculated as in (21). Thus, we get the following three calculations:

$$D_{SEK,1} = -1 \cdot 1\,470\,000 \cdot 0.71 = -1\,043\,700$$
$$D_{SEK,3} = (0.93 \cdot 20\,000\,000 \cdot 1) + (1 \cdot 7\,870\,000 \cdot 1) = 26\,470\,000$$
$$D_{EUR,2} = 1 \cdot 16\,335\,000 \cdot 1 = 16\,335\,000$$

The buckets can now be aggregated to the effective notional amounts, EN_j as in (19) which yields:

$$EN_{SEK} = \sqrt{(-1\,043\,700)^2 + (26\,470\,000)^2 + 0.6 \cdot (-1\,043\,700) \cdot 26\,470\,000} \simeq 26\,175\,832$$
$$EN_{EUR} = 16\,335\,000$$

Now, we can calculate the hedging set add-ons using the IR supervisory factor ($SF^{IR} = 0.5\%$) and then aggregating these to get the total add-on. This yields:

$$AddOn^{IR} = 0.5\% \cdot 26\,175\,832 + 0.5\% \cdot 16\,335\,000 = 212\,554 \text{ SEK}$$

17.2.2 Calculations for FX hedging sets

For FX derivatives, perfect offsetting is allowed within hedging sets. This yields the following effective notional amount and hedging set add-on:

$$AddOn^{FX}_{HS_j} = SF^{FX}_j \cdot |EN^{IR}_j| \tag{22}$$
$$EN^{FX}_j = \sum_{i \in HS_j} \delta_i \cdot d^{FX}_i \cdot MF_i \tag{23}$$

Here, the adjusted notional amount d^{FX}_i is defined as notional amount of the FX leg converted into domestic currency. If there are two FX denominated legs, the leg with the larger value is used. Furthermore, the add-on for the different hedging sets is aggregated without any offsetting benefits across hedging sets. Hence, the total add-on for FX derivatives within a netting set is defined as:

$$AddOn^{IR} = \sum_j AddOn^{FX}_{HS_j} \tag{24}$$

Example: FX hedging set calculation

For the FX derivatives in our example portfolio we have the properties shown in the table below. Here, the adjusted notional amounts are the same as the notional amounts in CEM.

Nr	Instrument	Notional amount (SEK)	HS	δ_i	MF_i
5	FX Swap	900 000	SEK/EUR	-1	1.0
6	FX Swap	900 000	SEK/EUR	1	1.0
7	Currency Swap	3 250 000	USD/SEK	1	1.0

The first step is to calculate the effective notional amount EN_j and $AddOn_{HS_j}$ for the two hedging sets (note that trade 5 and 6 belongs to the same hedging set). Thus, by using the relations in (22) and (23) we get:

$$\begin{aligned} AddOn_{EUR/SEK} &= 0.5\% \cdot |(1 \cdot 900\,000 \cdot 1.0) \cdot (-1 \cdot 900\,000 \cdot 1.0)| = 0 \\ AddOn_{USD/SEK} &= 0.5\% \cdot |1 \cdot 3\,250\,000 \cdot 1.0| = 16\,250 \end{aligned}$$

Thus, the total add-on for the netting set is:

$$AddOn^{FX} = 0 + 16\,250 = 16\,250 \text{ SEK}$$

17.2.3 Calculations for CR, EQ and CO hedging sets

The calculations for CR, EQ and CO derivatives are performed almost in the same way. The offsetting benefits are given on an entity level where the effective notional amount for entity k (E_k) is defined as:

$$EN_j^{AC} = \sum_{i \in E_k} \delta_i \cdot d_i^{AC} \cdot MF_i \tag{25}$$

Here,

- d_i^{CR} is calculated as for IR derivatives, i.e. converted to domestic currency and multiplied with the supervisory duration.
- d_i^{EQ} is the current price of the stock multiplied by number of units held.
- d_i^{CO} is the current price of the unit multiplied by the number of units referenced by the trade.

Moreover, the add-on factor for entity k is:

$$AddOn_{E_k}^{AC} = SF_k^{AC} \cdot EN_k^{AC} \tag{26}$$

These add-ons are then aggregated and partial offsetting is allowed. Here, the correlation parameters from Table 8 divides the aggregated add-on into a systematic component (where full offsetting is applied) and an idiosyncratic component (where no offsetting is applied). Remember that for CR and EQ derivatives there are only one hedging set. This leads to the total add-on:

$$AddOn^{AC} = \sqrt{\underbrace{(\sum_k \rho_k^{AC} \cdot AddOn_{E_k}^{AC})^2}_{\text{syncratic component}} + \underbrace{\sum_k (1 - (\rho_k^{AC})^2) \cdot (AddOn_{E_k}^{AC})^2}_{\text{ideosyncratic component}}} \tag{27}$$

Note that for CO derivatives, the entity instead refers to different types of commodities. Within these types, perfect offsetting is allowed and they are then aggregated as in (27). Furthermore, between the for CO defined hedging sets, no offsetting is allowed.

Example: Remaining hedging set calculations

For the example portfolio we have the following features

Nr	Instrument	Notional amount (SEK)	Entity	ρ_i	δ_i	MF_i
8	Stock option	100 000	Company X	50%	0.33	1.0
9	Index option	2 250 000	OMXS30	80%	-0.73	1.0
10	CDS	800 000	Country X	80%	-1	1.0
11	Commodity option	510 000	Oil/gas	40%	0.86	1.0

Calculations for EQ trades

First, we calculate the add-on for the EQ related trades that are also included in the netting set. Recall that there is only one hedging set for EQ trades. However, there are two entities which yield the following effective notional amounts:

$$EN^{EQ}_{CompanyX} = 0.33 \cdot 100\,000 \cdot 1.0 = 33\,000$$
$$EN^{EQ}_{OMXS30} = -0.73 \cdot 2\,250\,000 \cdot 1.0 = -1\,478\,250$$

Thus, given the supervisory factors in Table 7, the entity add-ons are:

$$AddOn^{EQ}_{CompanyX} = 32\% \cdot 33\,000 = 10\,560$$
$$AddOn^{EQ}_{OMXS30} = 20\% \cdot -1\,478\,250 = -295\,650$$

Now, the entity add-ons can be aggregated as in (27) which yields:

$$AddOn^{EQ} = \sqrt{\big(50\% \cdot 33\,000 + 80\% \cdot (-1\,642\,500)\big)^2 + (1-50^2\%) \cdot 33\,000^2 + ...} \\ \overline{... + (1-80^2\%) \cdot (-1\,642\,500)^2} = 291\,587 \text{ SEK}$$

Calculations for CR and CO trades

First, recall that the adjusted notional amount for CR derivatives is the notional amount multiplied with the supervisory duration SD_i. Thus, we get the following for trade 10:

$$d_{10} = 800\,000 \cdot 7.87 = 6\,296\,000$$

Now, in similarity to the EQ trades, we start with calculating the effective notional amount which yields:

$$EN^{CR}_{CDXIG} = -1 \cdot 6\,296\,000 \cdot 1.0 = -6\,296\,000$$
$$EN^{CO}_{Oil/gas} = 0.86 \cdot 510\,000 \cdot 1.0 = 438\,600$$

Thus, since no aggregation is needed we get the following two entity add-ons (using the supervisory factors in Table 7) which are equal to the asset class add-ons:

$$AddOn^{CR} = 0.38\% \cdot |-6\,296\,000| = 23\,925 \text{ SEK}$$
$$AddOn^{CO} = 20.0\% \cdot |438\,600| = 87\,720 \text{ SEK}$$

17.3 Multiplier

To meet the critique towards CEM regarding recognition of over-collateralization, the multiplier is introduced in SA-CCR to reduce the add-on for a netting set which is subject to over-collateralization. In addition, the multiplier should recognize the effect of negative exposures which were not recognized under CEM. Thus, the multiplier is calculated for each netting set and is defined as follows:

$$multiplier = min\left(1; floor + (1-floor) \cdot exp\left(\frac{V-C}{2 \cdot (1-floor) \cdot AddOn^{aggregate}}\right)\right) \quad (28)$$

Hence, the multiplier is floored by the parameter floor which is set to 5%. The add-on will therefore be reduced by a factor in the interval [0.05,1] depending on the level of over-collateralization and negative MTM-values within the netting set. Figure 3 shows how the multiplier behaves when $\frac{V-C}{AddOn^{aggregate}}$ varies.

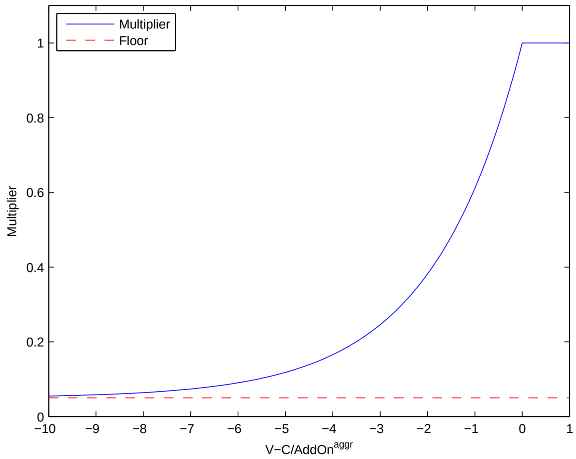

Figure 3: The multiplier

Example: Calculation of the multiplier

In order to calculate the multiplier for the netting set in the example portfolio we first need the sum of market values, V, for these trades.

$$V = \sum_{i=1}^{11} V_i = 45\,300 + 230\,000 + ... - 123\,000 = -700$$

Furthermore, we need the aggregated add-on for the netting set which is given by:

$$\begin{aligned} AddOn_{NS} &= AddOn^{IR} + AddOn^{FX} + AddOn^{EQ} = ... \\ &= 212\,554 + 16\,250 + 291\,587 = 520\,391 \text{ SEK} \end{aligned}$$

Note that trade 10 and 11 are not included since they are not covered by the netting agreement. Since we know the collateral amount (100 000 SEK) we can now calculate the multiplier:

$$multiplier_{NS} = min\left(1; 0.05 + (1-0.05) \cdot exp\left(\frac{-700-100\,000}{2 \cdot (1-0.05) \cdot 520\,391}\right)\right) \simeq 0.91$$

For the two trades not covered by netting agreements we get:

$$multiplier_{10} = min\left(1; 0.05 + (1-0.05) \cdot exp\left(\frac{-7\,000}{2 \cdot (1-0.05) \cdot 23\,925}\right)\right) = 0.86$$
$$multiplier_{11} = min\left(1; 0.05 + (1-0.05) \cdot exp\left(\frac{38\,000}{2 \cdot (1-0.05) \cdot 87\,720}\right)\right) = 1.00$$

18 Critique towards SA-CCR

After the first consultative document [11], where a new method (then called NIMM) for calculating EAD was published by BIS, a number of institutions in the financial industry and other interest organizations soon published documents with responses to the proposed new model. Most of the responses were very positive to the initiative to develop a successor to both CEM and SM because both financial institutions and regulators find the current non-internal methods too conservative and not capable of capturing the risk in an adequate way. However, despite the optimism from the industry, some criticisms were leveled against the new method. After considering the responses, BIS reviewed the new method and published the final version under the new name SA-CCR. In this updated version of the method some of the earlier critique has been adjusted for. However, some of the critique expressed by the industry has not been changed and the effect of these might still be important to take under consideration.

The German Banking Industry Committee expressed concerns about the complexity of the new method. The committee was particularly concerned about small and mid-sized institutions with low trading volumes. The committee argued that the new method is too complex to be called a "standard approach". Here, ISDA, together with IIF and GFMA, [17] however argue that the model in general is not too complex but rather too simplistic. On the other hand, they propose that a simplified version of the model should be permitted under supervisory review for smaller institutions.

The industry has also expressed skepticism towards usage of the α factor with a value of 1.4. The German Banking Industry Committee writes that applying the alpha factor will take out the effect of the multiplier and the attempts to recognize benefits of over-collateralization. In the document published by ISDA, IIF and GFMA in September [17] the three associations argue that the α factor is too conservative because SA-CCR is not subject to model risk to the same extent as IMM and that the errors occurring from the simplifications and assumptions are compensated by the conservative supervisory factors. In the same document ISDA, IIF and GFMA express concerns about including MPOR in the maturity factor that is multiplied with the aggregated add-on for margined transactions. If MPOR in some case would be greater than approximately 160 days, the factor would be greater than one and will therefore increase the add-on instead of mitigating it. However, this is usually not the case but could be possible for very illiquid securities. However, one can argue that having an MPOR of over 160 days could be considered a risk in itself and the construction of the maturity factor may therefore be reasonable.

Both Deutsche Bank [1] and BNP Paribas [6] have expressed concerns that FX positions are not allowed to net through "triangulation" in SA-CCR. The reason is that FX derivatives are divided into hedging sets with respect to a currency pair. To understand the concept of triangulation we can consider a contract containing three currencies EUR,USD,SEK arranged in the following way:

Long: EUR/USD, long USD/SEK and long SEK/EUR

Here, the add-on will according to SA-CCR just sum the add-on for each currency pair even if the exposure actual is zero.

Deutsche Bank has also comment on the cases where TH+MTA-NICA is large for margin transactions, in some cases much larger than V-C. This causes that RC gets significantly larger than if the same transaction where unmargined. The result is that margin transactions are treated more conservative than unmargined transactions in these cases which does not make sense. Deutsche Bank also argues that the scale factor 3/2 that is included in the definition of the maturity factor for margined transactions explained in section 17.1.6 in combination with the definition of RC discussed above is double counting for the same risk and therefore either TH+MTA-NICA or the scale factor 3/2 should be dropped.

Part VI
Methodology

When determining and mapping out differences and similarities between the two models, two focus areas have been chosen: the netting effect and asset class comparison. This since the rules for netting in the two models is one of the largest technical differences. In addition, an asset class comparison is added to locate where there are large differences and what is driving EAD. The asset class comparison was chosen as a focus area mainly due to changes in the add-on calculations in SA-CCR for different asset classes compared to CEM. In the evaluation of the netting effect and in the asset class comparison we used a number of randomly selected sub-portfolios. However, in order to get an overall apprehension of the change in EAD the whole original portfolio, consisting of ten counterparties, was also analyzed without any random selection.

19 Data gathering and selection

The trade information used was extracted from a commercial bank's front office system. The front office system used in this particular bank is SunGard Front Arena Prime. The selected trades belonged to different asset classes and a wide range of instrument types. However interest rate and foreign exchange derivatives was clearly dominating, as shown in Table 10 and Table 11. Combination instruments, total return swaps, basis swaps and volatility transactions were excluded because of the inconsistency in the set up for these trades in the front office system and uncertainty regarding how these should be treated in the new SA-CCR method.

Both CEM and SA-CCR were implemented using Python in order to enable calculations of EAD under CEM and SA-CCR simultaneously for the selected trades. The calculations were performed both with netting allowed within the netting sets and stand alone. Here, stand alone implies that all trades are treated as its own netting set, thus no netting benefits are recognized. The term stand alone will be used throughout the report and refers to this condition. For aggregation of interest rate derivative buckets, equation (19) was used, i.e. partial offsetting between maturity buckets was allowed within each hedging set. Furthermore, when investigating the behavior of the EAD under SA-CCR compared to CEM for netting effects, ten counterparties were chosen and used in the analysis. The selected counterparties are other financial institutions and all fulfilled a requirement of containing over 200 trades. Thus, this resulted in a portfolio of 10 netting sets and approximately 5 300 trades which were analyzed. Table 10 shows which type of instruments that are represented in the selected portfolio. Seven counterparties were used in the asset class comparison since the other three did not have enough trades in each asset class. Some of the chosen netting sets are also subject to margin agreements. Matlab was used for statistical analysis and presentation of results.

Instrument type	Number of contracts
Intrest Rate Swap	3488
Option	635
Foreign Exchange Swap	384
Forward Rate Agreement	349
Currency and Cross Currency Swap	329
Intrest Rate Cap	71
Intrest Rate Floor	20
Credit Default Swap	6
Free Defined Cash Flow	4
Index Linked Swap	1
Total	**5 287**

Table 10: Number of contracts per instrument type in the selected portfolio

Most of the parameters required for the calculations could be extracted directly from the front office system either on the trade level or on the instrument level. For the delta adjustment parameters, the primary risk factor was determined for each contract. To be able to tell if the contract was long or short in the primary risk factor the valuation curve for each underlying instrument was changed and delta was set depending on the direction of the contract's value resulting from the change. In addition, because difficulties in extracting price of the underlying asset and strike price from the the front office system, options was only given delta values of 1 and -1 (instead of the values defined in Table 5) and distinction of credit derivative ratings was not considered.

To give the reader a better picture of the selected portfolio Table 11 is provided. The table shows the MTM-values and the notional amounts for each asset class and the proportion it represents.

Asset Class	MTM-value (SEK)		Notional amount (SEK)	
IR	4 426 625 813	(53%)	2 272 003 117 464	(87%)
FX	3 072 736 035	(36%)	328 788 955 196	(13%)
EQ	918 741 650	(11%)	9 344 286 847	(0.36%)
CR	3 616 348	(0.04%)	413 827 865	(0.016%)
CO	34 178	(0.0004%)	1 318	(<0.0001%)

Table 11: MTM values and notional amounts in SEK and portion of the selected portfolio per asset class

The time to maturity of the trades is of great importance especially for CEM but also for SA-CCR where IR trades are multiplied with supervisory duration. To give the reader an overview of the maturities for the trades that are included in the selected portfolio Table 12 is provided which shows how the trades are distributed in the maturity buckets.

Residual maturity	IR	FX	EQ	CR	CO	Total
$<$ 1 year	1 085	643	132	1	2	1 863
$>$ 1 year or $<$ 5 years	2 279	109	145	5	-	2 538
$>$ 5 years	863	23	-	-	-	886

Table 12: Distribution of trades within maturity buckets per asset class

20 Portfolio snapshot

The overall changes in the selected portfolio where evaluated for all the trades belonging to the selected counterparties before any sampling was made. Thus, an overall evaluation of what the transition to the SA-CCR could imply in terms of exposure could be performed. Even though this is only a snapshot it gives an indication and exemplifies what this transition may imply in terms of overall change in minimum capital requirement for CCR for a Swedish commercial bank.

21 Netting effects

If considering the definition of the two models one can observe that there is a large difference in how netting is recognized in the calculation of the add-on. As mentioned, CEM only allows recognition of netting benefits up to 60% whereas the SA-CCR, due to its incorporated delta, can recognize full netting benefits in the add-on within the hedging sets. This is something also acknowledged by industry experts already when the first version of the new method (NIMM) was proposed in June 2013. For example, Schwob [16] from SunGard, believes that the exposure will be higher for single trades but lower on the netting set level due to the increased allowance to net under SA-CCR. Thus we want to test the following hypothesis:

- **Hypothesis 1:** EAD will be lower under SA-CCR when netting is allowed.

However, it is not obvious how the new concept of hedging sets included in SA-CCR will affect the overall recognition of netting for a complete netting set. A possible scenario is that the increased recognition of netting benefits is restricted due to the division into hedging sets.

In addition, the SA-CCR might imply a higher charge for stand alone trades. This since SA-CCR incorporates the scale factor α of 1.4 but also because SA-CCR seems to be more penalizing on IR trades. Especially on IR trades that matures within one year. Hence, the following hypothesis will also be tested:

- **Hypothesis 2:** EAD will be higher when netting is not allowed (i.e. calculated stand alone) and thus on a single trade level under SA-CCR.

To test these hypotheses, EAD is calculated for the portfolio as the sum of EAD for each trade, stand alone, and then compared to the netted EAD for the same trades. In order to test for different combination of trades and portfolio, trades were randomly selected (with replacement) from the netting sets in buckets of 10 to 200 trades. Thus, portfolios of 100-2000 trades were analyzed. The use of many different netting sets, instead of one large, is to fully incorporate the dynamics of a complete portfolio since the counterparties and netting sets have different characteristics (such as margin agreements). The procedure of picking trades for these netting sets is then repeated 500 times for each bucket. This was done in order to mitigate the effect of single trades. Histograms where generated and will be analyzed in Section 25.

To see whether there are statistically significant differences between the two approaches SA-CCR and CEM a parametric paired sample Student's t-test was performed for each bucket. The paired sample t-test was used since EAD was calculated with two methods on the same portfolios for each run which gives a natural dependence between the two resulting EADs. The t-test requires assumptions regarding the distribution and after observing the histograms of the distribution of differences, they could be assumed to be approximately normally distributed. This test was performed on a significance level of 5%.

In the joint response on Basel's proposed new model by ISDA, IFF and GFMA [17] the associations expresses an interest in investigating the standard deviation of the new SA-CCR measure in comparison to the CEM in addition to the absolute values. This can acknowledge the effects of single trades. Thus, using the samplings described in the previous section allowed for an analysis of the potential differences in sample standard deviation between the measures for different number of trades.

22 Asset class comparison

Since SA-CCR requires different calculations for different asset classes in contrast to CEM this might imply that there are differences in EAD between the asset classes. First, an overall comparison of EAD for the different asset classes was made to see the proportions of each asset class (this results will be presented in Section 24). This comparison showed that EAD for IR and FX trades represented over 99% of the total EAD in our selected portfolio. This, can also be observed in terms of MTM and notional values in Table 11. Thus, trades for the remaining asset classes were limited and only interest rate and foreign exchange derivatives were considered in the comparison. In addition, IR and FX derivatives are of particular interest since they are generally more used than derivatives in other asset classes and will therefore affect EAD most for most financial institutions.

Due to technical differences in the methods, there are some differences that could be expected in EAD between the two models for the specific asset classes. First, interest rate derivatives with maturity less than one year will, under CEM, be given an add-on of zero. For the SA-CCR, on the other hand, this is not the case. Here the supervisory duration SD_i will adjust the notional amount together with the multiplier, maturity factor MF_i and supervisory factor SF_i. This might therefore lead to a higher EAD for IR derivatives when considered stand alone and the following hypothesis is to be tested:

- **Hypothesis 3:** EAD will be higher for IR derivative portfolios when netting is not allowed (i.e calculated stand alone) under SA-CCR.

In addition, we want to investigate whether there are any differences in EAD for FX derivatives. In this case it was hard to formulate a hypothesis based on the technical definition since there are factors that seem to scale PFE upwards while others seems to scale it downwards. For an FX derivative is PFE (including the α factor) calculated as:

$$1.4 \cdot MF_i \cdot \delta_i \cdot SF_i \cdot Multiplier \cdot d_i \tag{29}$$

MF takes the value 1 if there is more than one year to maturity, SF is always 0.04 and δ is either 1 or -1 for most trades. By trying different times for maturity in $1.4 \cdot MF \cdot \delta \cdot SF$ we could see that this product was always greater than the $AddOnFactor$ in CEM if time to maturity was more than 11 days and less than 5 years (assuming no margin agreement was present). After 5 years is the product always 0.056 and the corresponding $AddOnFactor$ is

0.076. The multiplier will only have a mitigating effect in cases of over-collateralization or negative market values when margin agreements are not present. Hence, no hypothesis is formulated but we want to investigate if:

- **Question 1:** Will EAD be higher for foreign exchange derivatives under SA-CCR?

In similarity to the netting set analysis, trades was randomly selected (with replacement) in order to see how EAD varies between the methods and the IR and FX asset classes respectively. However, due to the limited amount of trades for a single asset class for one counterparty only 20 trades were picked each run from each of the counterparties. Seven counterparties fulfilled this requirement and were therefore used to perform this analysis. Histograms with EAD both netted and stand alone for the IR and the FX portfolio were generated.

After analyzing the histograms presented in Section 26, an approximate normal distribution could be assumed and a paired sampled Student's t-test was also performed for these portfolios. The Student's t test will be explained in the next section.

23 Paired sampled t-test

This section explains the paired sampled Student's t-test used for comparing the two methods. The Student's test here is defined as by Blom [2, p.100] Student's test can be used to test if the mean of a difference between two populations is non zero. Furthermore, it is assumed that EAD_{CEM} for portfolio i in the series of n portfolios with m number trades comes from a normal distribution $N(\mu_i,\sigma_1)$ and EAD_{SA-CCR} from another normal distribution $N(\mu_i + \Delta,\sigma_2)$, where Δ represents the systematic difference between the two models. A new series is created for the difference between EAD_{SA-CCR} and EAD_{CEM} for the n portfolios and that difference comes from a distribution $N(\Delta,\sigma)$. Here, $\sigma = \sqrt{\sigma_1^2 + \sigma_2^2}$.

The null hypothesis tested is: $\Delta = 0$ i.e the mean of the difference between the populations is zero

The test statistic is defined as:

$$t = \frac{\overline{x} - \mu_0}{s/\sqrt{n-1}} \tag{30}$$

Here, $\overline{x}$ is the mean for the differences, $\mu_0 = 0$ in accordance to the null hypothesis, s is the standard deviation of the difference and n is the number of pairs. The degrees of freedom are $n-1$ because the sample is used to estimate the mean and therefore one degree of freedom is lost. The test statistic is compared with the corresponding value of the t-distribution for n degrees of freedom and the significance level required. If the test statistic is greater than the corresponding value form the t-distribution the null hypothesis is rejected. The confidence interval for the difference is also calculated to be able to see if the real mean is positive or negative which will give us information about which model gives the greater value to complement the information that there is a difference. The confidence interval is defined as:

$$I_\Delta = (\overline{x} \pm t_{\alpha/2}(n-1) \cdot d) \tag{31}$$

where $d = s/\sqrt{n}$.

Part VII
Results and Analysis

All results from the study will be presented and analyzed in this part. First, a snapshot of the selected portfolio is visualized where EAD is calculated under both CEM and SA-CCR. This in order to give the reader a picture of what type of portfolio has been used for generating the results. Furthermore, the following section includes results for the sampled portfolios for which the netting effect is analyzed for both CEM and SA-CCR. These sections also include the results from the paired sample t-tests and histograms showing the empirical distribution of EAD for both CEM and SA-CCR in order to analyze differences. Lastly, the results of the comparison between the asset classes FX and IR are presented.

24 Portfolio snapshot

In order to get an overall picture of how using SA-CCR would affect the selected portfolio (i.e. the sum of all trades within the chosen counterparties and netting sets) EAD was calculated both with netting allowed and stand alone for whole selected portfolio without sampling.

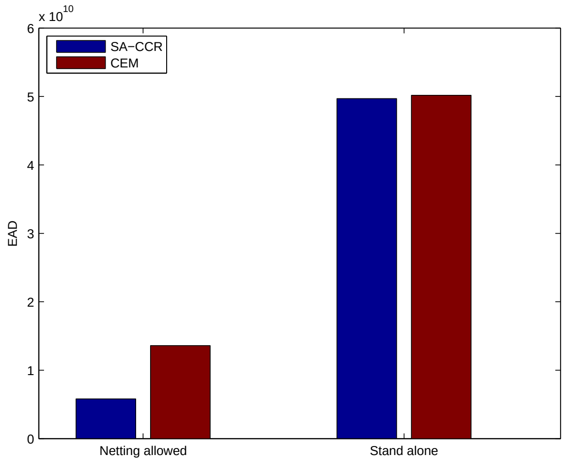

Figure 4: EAD calculated on the original portfolio before sampling

Here, Figure 4 elucidates the importance of netting for the total EAD of the selected portfolio. This effect is something that can be observed for both CEM and SA-CCR. However, the netting effect of the methods as well as the absolute level of EAD is significantly different. Here, netting is clearly more recognized in SA-CCR. In addition, the level of EAD when it is calculated stand alone is also considerably different. Thus, this implies that enforcing a transition to SA-CCR would lower EAD for the selected portfolio.

In Figure 5 the composition in terms of EAD and number of trades is shown. Here, netting is allowed in the calculation of EAD.

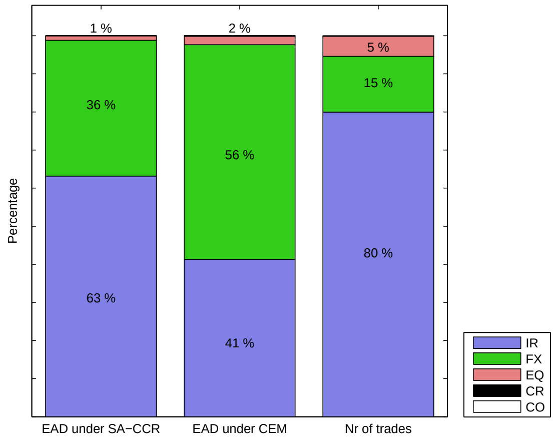

Figure 5: Portfolio composition

As can be observed in Figure 5 is EAD significantly larger for foreign exchange derivatives in relation to its proportion of the portfolio in terms of number of trades. This can partly be explained by the fact that foreign exchange contracts generally have a higher volatility and is therefore given a more punitive add-on than for example interest rate contracts. This is something that can be observed in both CEM and SA-CCR. However, the figure above also illustrate that there is change in composition where between the two methods. Here, foreign exchange derivatives are given a reduced exposure in comparison to interest rate derivatives for SA-CCR. This implies that SA-CCR might be less punitive towards foreign exchange trades. However, this will be further discussed in the asset class analysis in Section 26.

25 Netting effects

Sampling different number of trades made it possible to evaluate the netting effect and the difference between the models. Thus, Hypothesis 1 and Hypothesis 2 could be tested in order to determine whether they were correct or not. As shown in Figure 6, the mean for samplings in each “number of trade”- bucket clearly differs. The fact that EAD increases when the number of trades does is however not surprising. What is interesting about the results shown in Figure 6 is the improvement of netting for SA-CCR compared to CEM and that the netting effect is even better for SA-CCR when the portfolios are larger.

Furthermore, when EAD is calculated stand alone the picture looks somewhat different. As expected, SA-CCR seems to generate higher EAD is calculated stand alone in comparison to CEM even if the change is not as distinct. As shown in Figure 6, the mean EAD is somewhat higher for SA-CCR when the number of trades increases. An interesting observation is that the results presented in Figure 5 shows a higher EAD for CEM than it does for SA-CCR for the complete selected portfolio which is not the case here.

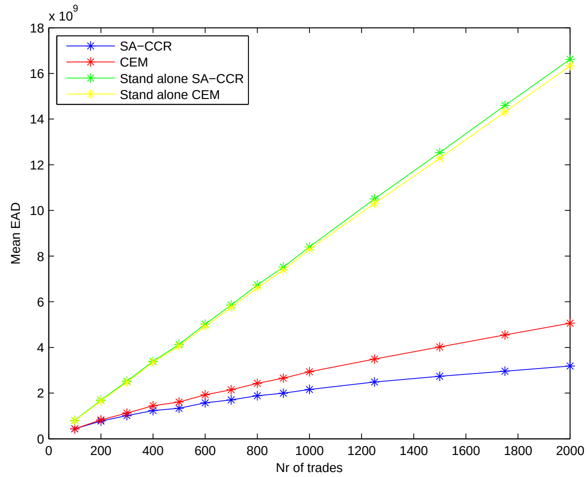

Figure 6: Mean EAD for different number of trades

If considering the mean EAD adjusted for the number of trades we can observe that the EAD per trade seem to decrease steadily for both methods (see Figure 7). In addition, it seems as the rate of decay is significantly larger for SA-CCR than for CEM. It can also be observed that the increase of the difference in mean EAD, per trade, between CEM and SA-CCR seem to decrease and converge towards 1 million SEK. The observation can be interpreted as that the portfolios are almost using the full potential netting effect that the methods allows and will therefore not improve the netting effect significantly by adding more trades.

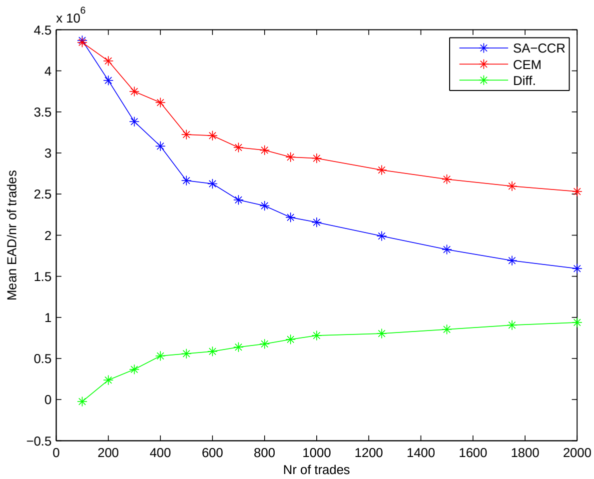

Figure 7: Mean EAD/trade for different number of trades

The paired sample t-test for the two series, whose means are observed in Figure 6 and Figure 7, shows that the difference between them is statistical significant. As shown in Table 13, we can see that the null hypothesis (i.e. that there is no difference) is rejected on a 5% level when the number of trades exceeds 200 trades (i.e. 20 trades per counterpart and i.e. netting set). The confidence interval was located on left side of the zero point for all portfolio sizes except from n=100. This implies that using the SA-CCR for calculating EAD, when netting is allowed, would reduce EAD and thus also the required minimum amount of capital held for this particular type of portfolio.

Nr of trades	**p-value**
100	0.6516
>200	< 0.01 *

* H_0 rejected on a 0.05 level

Table 13: Paired sample t-test, netting allowed

In addition, the difference is also significant as when EAD was calculated stand alone. Here, the paired sample t-test shows (see Table 14) that there is a difference between the series for all buckets tested with a significance level of 5%. When EAD was calculated stand alone the confidence interval was always located to the right of the zero point which indicates that SA-CCR gives higher EAD than CEM for all portfolios sizes.

Nr of trades	**p-value**
100	0.0062 *
200	0.0143 *
300	0.0020 *
400	0.0357 *
>500	< 0.01 *

* H_0 rejected on a 0.05 level

Table 14: Paired sample t-test, stand alone

In order to compare the netting effect of the two methods, histograms were generated for the fraction of EAD netted and EAD stand alone. This was done for the 500 randomly selected portfolios with 200 and 2000 trades. As shown in Figure 8 the mean of EAD for large portfolios under SA-CCR is located to the left of the mean of EAD for large portfolios under CEM which indicated that the netting effect is clearly better under SA-CCR for the large portfolios. By looking at these histograms it becomes obvious that it is the set-up of the methods that creates the differences and not a specific selection of trades. For the small portfolios there is no clear difference between the two methods. The distributions are more concentrated for large portfolios which is natural because large portfolios are less affected by individual trades.

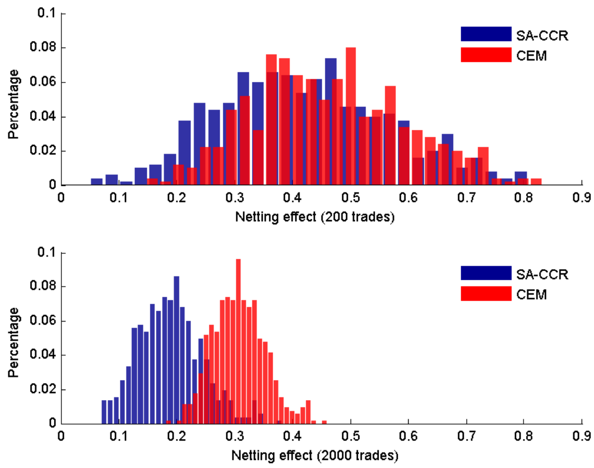

Figure 8: Histograms for portfolios cantaining 200 and 2 000 trades

Moreover, in Figure 9 the relative standard deviation is presented. As expected, the standard deviation decreases when the number of trades increases. This since the effects of single trades is diminished by the larger selection of trades.

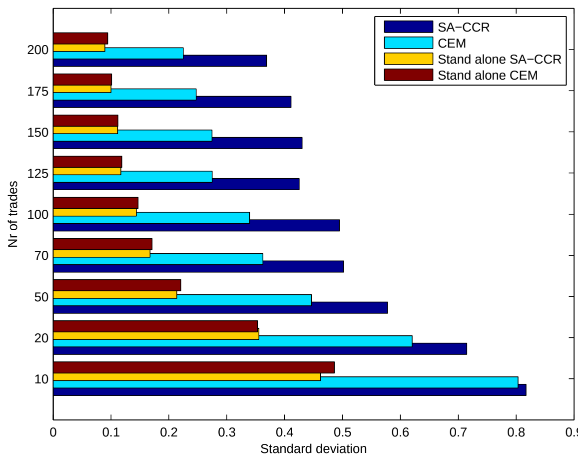

Figure 9: Standard deviation of EAD for both methods, netted and stand alone

Furthermore, the stand alone standard deviations are lower than the netted ones. This illustrates the effect of netting and how large its impact is on the total EAD of the portfolio. Since the portfolios in the above sampling are randomly selected, the netting effects for the respective method vary largely and probably more than it would for a real and strategically composed portfolio. However, this can imply that the trade selection of the portfolio becomes more important because the high variation in netting effect for different portfolio compositions.

26 Asset class comparison

As could be observed in Figure 5, IR and FX derivatives stands for the majority of the trades and naturally contributes for most of the EAD in the selected portfolio. This ascertainment of the results further motivates a complimenting comparison of IR and FX derivatives in particular and how EAD changes for these under SA-CCR compared to CEM.

Figure 10 shows the mean of EAD netted and stand alone for the 500 portfolios with 20 trades. By looking at Figure 10 we can see that the total difference of EAD for the portfolios seems to be mainly driven by a change in EAD for foreign exchange rather than interest rate derivatives. This since CEM seem to have a significantly higher mean EAD for foreign exchange contracts when sampling in comparison to the new SA-CCR, both when netting is allowed and when EAD is calculated stand alone. This implies that SA-CCR is less punitive for foreign exchange derivatives in our selected portfolio. However, consideringen the argumentation when formulatnig Question 1, it is difficult to draw any genereral conclusions about FX derivatives.

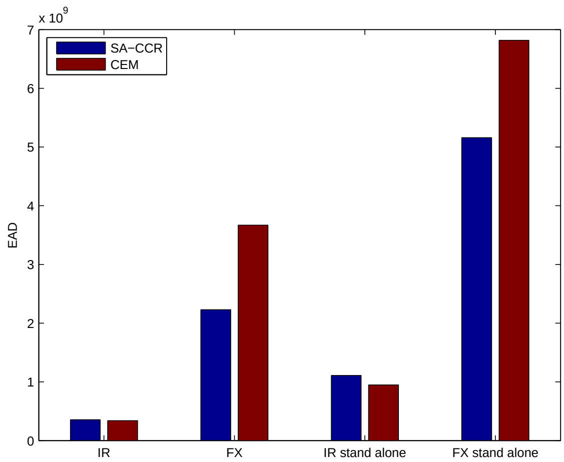

Figure 10: Mean EAD for FX and IR derivatives

As in the previous section, where the netting effect for sampled portfolios including all asset classes were analyzed, this was also done for FX and IR trades separately. Thus, histograms were generated for EAD in sampled portfolios that only included FX trades and IR trades set apart. The histograms in Figure 11 were generated by using 500 sampled FX portfolios with 20 trades. These histograms also further confirm the claim that changes in EAD for the total portfolio is highly driven by changes in EAD for the FX trades. This since the sampled distribution for the foreign exchange portfolio is more shifted to left for SA-CCR than CEM. This could indicate a better effect of netting for FX portfolios for SA-CCR as well as a less punishing add-on.

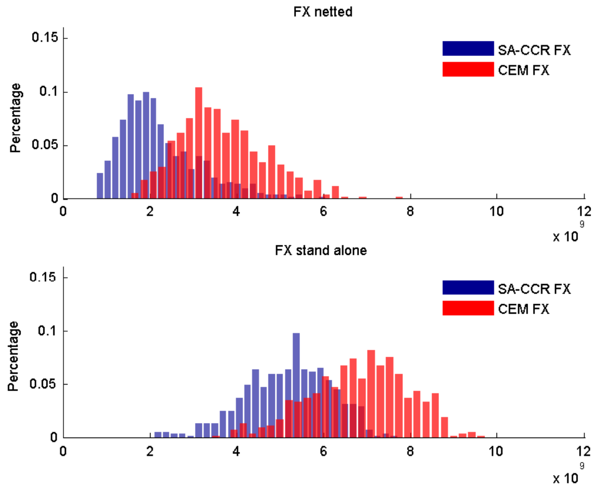

Figure 11: Histogram of mean EAD for FX portfolios

If considering Figure 12, where the same procedure is performed for IR trades, the differences between distributions of the two methods are not as clear for these trades. In fact, it looks like CEM gives lower EAD when calculated stand alone in comparison to SA-CCR. Consequently, it seems as when calculated stand alone, SA-CCR is more punitive than CEM for IR derivatives which speaks in favor of Hypothesis 3.

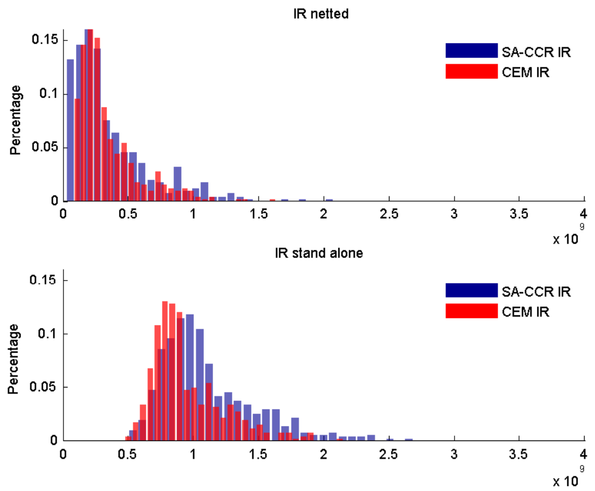

Figure 12: Histogram of mean EAD for IR portfolios

In addition, the dependent paired Student's t-test was performed for both FX and IR portfolios. However, since the histograms for the IR portfolios did not look normally distributed, histograms for the difference between CEM and SA-CCR were generated. If the distribution of differences can be considered at least approximately normal it could be appropriate to use the dependent paired Student's t-test in order to test for differences and confirm the claims above.

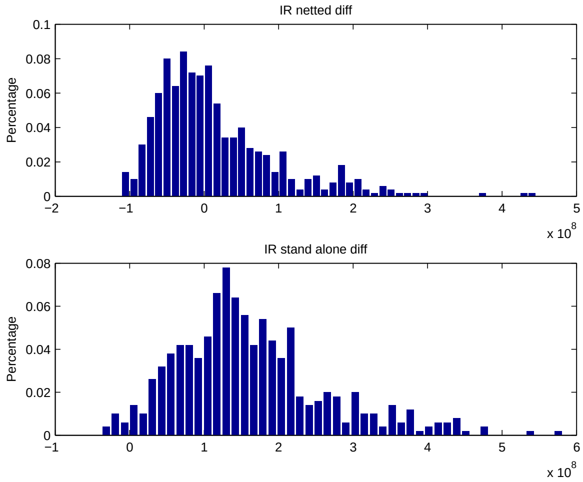

Figure 13: Histogram for CEM/SA-CCR difference

As can be observed in Figure 13, the histograms for the difference look at least approximately normal. Thus, a paired sampled t-test was performed for IR portfolios to get an indication of the difference between methods for IR derivatives.

The Student's t-tests showed that there is a significant difference for both the FX portfolios and the IR portfolios containing 20 trades when netting was allowed and when EAD was calculated stand alone. The confidence interval was located to the right of the zero point for IR portfolios both netted and stand alone and to the left for the FX portfolios. This implies that EAD under SA-CCR is greater for IR portfolios both when netting is allowed and when EAD is calculated stand alone and the other way around for FX portfolios which confirms both Hypothesis 3 and 4 for these portfolios. However, the distribution for the differences is not clearly normally distributed so the results from these t-tests are treated as an indication rather than a proof. It would have been interesting to perform the same tests on portfolios containing more trades but the limited access to suitable trades does not make that possible in this study.

	Netted	**Stand alone**
IR	< 0.01*	< 0.01*
FX	< 0.01*	< 0.01*

* H_0 rejected on a 0.05 level

Table 15: p-values, asset class comparison

Furthermore, it must be noted that in this asset class comparison the number of trades chosen might also have an effect on the results when netting is allowed. The fact that the difference for FX trades are more clearly recognized can be due to the less conservative allowance of netting within the hedging sets. This since full offsetting is allowed within hedging sets, i.e. currency pairs, for FX trades whereas there is only full offsetting within maturity buckets (per currency) for IR trades. Consequently, it might be helpful to create a similar analysis between asset classes for a larger set of trades as well.

Part VIII
Conclusions and Discussion

There are two different and important discussions that are interesting in the context of introducing this new method. One of these discussions is concerning how adequate the method is in reflecting the true CCR of the portfolio. Thus, this discussion is regarding how sufficient the model is in reflecting the reality. As discussed in Section 15, CEM is an old method which has been criticized for not capturing the risk in a compelling way. Thus, in this context there is a need for a new, more risk sensitive, refined and less static method. The successor SA-CCR aims to meet the critique given to its predecessors and it cannot be denied that the calculation of EAD under SA-CCR is far more complex than it was under CEM. Consequently, SA-CCR requires more detailed information about each trade that was not necessary under CEM. Furthermore, SA-CCR is less static than CEM which further increases the complexity since specific features of individual instruments are recognized. If this increased complexity is considered positive or not is very subjective. The purpose of a non-internal method is to allow smaller institutions that are not capable or interested in modeling to use a method that requires fewer resources than what are required for implementing and maintaining IMM. Instead, the non-internal model is more conservative and generally leads to a somewhat higher minimum capital requirement. In addition, the increased level of complexity might create complications and incur high costs for institutions that today do not have the capacity and ability required. With a higher level of sophistication, SA-CCR makes the complexity level gap between using a non-internal method and an internal model shrink. This may encourage banks to develop an internal model and aim to get approval for using it which should result in an even lower EAD than under SA-CCR.

Another important discussion is regarding how this change might impact the levels of EAD, which is more thoroughly discussed in this study. This is important since EAD affects the overall minimum capital requirement for banks and consequently also the related capital costs (since it naturally does costs money to hold capital instead of using it for something else). Furthermore, how EAD changes between instruments and asset classes might also affect how banks choose to compose their portfolios, especially if the changes in EAD are large for a specific instrument or asset class. The results and the analysis in Part VII shows that EAD is in general lower under SA-CCR than under CEM for our portfolio when netting is allowed as suggested by Hypothesis 1. In addition, the difference is greater for large portfolios than for small portfolios on a trade level due to the increased netting effect. Consequently, it can be concluded that SA-CCR recognizes the benefits of netting better than CEM for our portfolio despite that the concept of hedging sets is introduced in SA-CCR. We can also conclude that improvements of the netting effect, by adding more trades, decreases steadily. Thus, this implies an overall lower level of EAD if switching to SA-CCR. In addition, this also suggests that this new method better reflects the actual risk (which is lower than under CEM) because of the increased recognition of netting. So, even if SA-CCR also has been somewhat criticized for not fully recognize the benefits of netting, it is still an improvement from CEM.

Moreover, when EAD is calculated stand alone, SA-CCR generates a slightly higher EAD as suggested by Hypothesis 2. However, the difference is not as significant between the models as when netting is allowed which was shown in Figure 6. Consequently, the results from this study implies that a change from CEM to SA-CCR could result in lower minimum capital requirements in general for mid-sized and large institutions who has netting sets large enough to benefit from the increased netting effect. For small institutions or institutions with fewer trades per counterparty, on the other hand, the effect might be the reverse. However, the size of the difference between the methods was not as large for stand alone trades as expected which imply that the effect may not be as punishing for small institutions as previously believed. Hence, the results can be interpreted as follows: changing from CEM to SA-CCR might lead to that small financial institutions (with few trades or few netting agreements) can be required to hold slightly more capital with SA-CCR than with CEM while larger institutions (with more trades within netting sets) may benefit from the better recognition of netting under SA-CCR.

Note however that the assumptions and conclusions above naturally rely on the assumed asset class composition in the particular portfolio used in this study. In the selected portfolio where netting effects and the absolute levels of EAD were studied there was a vast majority of IR trades. As showed in for example Figure 10, EAD was higher for IR derivatives under SA-CCR than when EAD was calculated stand alone as suggested by Hypothesis 3. Thus, the fact that the stand alone EAD for the selected portfolio was higher using SA-CCR might be a consequence of IR trades being more punished when considered stand alone. This is caused by, among other factors, the significant difference in add-on calculation for these kinds of trades when for example residual maturity is less than one year as well as the punishing supervisory duration. This is because, IR trades with maturity within one year is not assigned any add-on at all under CEM but under SA-CCR they all get an add-on no matter how soon the date for maturity is.

Moreover, it could also be observed that FX derivatives were a primary driver of the change in EAD in our portfolio among the different asset classes. As shown in Figure 10, EAD was lower under SA-CCR for FX derivatives both when netting was allowed and when EAD was calculated stand alone. More tests are needed on other portfolios to any general conclusions how SA-CCR will affect FX derivatives. However, if the results from this study shows to be generalizable it may encourage financial institutions to take larger positions in FX trades which will be cheaper in terms of minimum capital requirements under SA-CCR compared to CEM.

The new SA-CCR has also been criticized for is not reflecting RC adequately, as discussed in Section 18. This since RC under SA-CCR includes TH+MTA-NICA which might give a very high RC when TH or MTA are large (which is not unusual). This new feature can contribute to a higher EAD when margin agreements are present even if a margin agreement in fact lowers the risk. Moreover, when the number of trades in the netting set increases the effect of high RCs can decline due to the increase in market value (that exceeds collateral). The effect of the TH+MTA-NICA did not significantly affect the portfolio in this study. However, using this factor might still be inappropriate when trying to reflect the risk in an adequate way.

Furthermore, the analysis of the standard deviation, shown in Figure 9 showed that the sampled standard deviation is higher for SA-CCR than for CEM for our portfolio. The result further implies that the portfolio composition is more important under SA-CCR than under CEM. Consequently, the overall increased netting effects, could make it possible for banks to optimize their portfolios with respect to EAD to a higher extent under SA-CCR than under CEM. This is interesting since it may encourage banks in some sense put more effort in finding trades that will generate better netting but that solution may on the other hand be suboptimal when considering other types of risks the portfolio. Considering this study and its results in isolation would invite to draw conclusions like; minimizing the number of counterparties would minimize the EAD (up to a limited number of trades), minimize the number of asset classes, since concentrating the trades to few counterparties and asset classes would maximize the netting benefits. Even if that might be true it should not be forgotten the capital requirements depend on other components and risk types. Minimizing the number of counterparties may, to a certain level, lead a lower EAD but could instead increase the concentration risk which is to be calculated under Pillar II of Basel II. Minimizing the number of asset classes may give lower EAD but at the same time other risk mitigating effects like diversification will be less. However, to investigate if the effects of optimization with respect to EAD will be positive than negative for the overall risk is subject for future research.

27 Limitations

When the methods were implemented, some simplifications had to be made due to limitations in what was possible to extract from the front office system within reasonable time. Thus, regarding collateral it has been assumed that all collateral is posted in cash. Since cash is considered to be the safest type of collateral, it is not assigned a haircut factor. Even if a haircut could have been applied to reflect changes in the exchange rate, it was excluded in this study. However, this does not affect the difference between the two methods since collateral and their haircuts are equal for CEM and SA-CCR.

There were further simplifications in the calculation of add-ons for the different asset classes that had to be made. For credit derivatives the supervisory factor for the BBB rating was assigned to all companies due to problems in extracting the correct credit ratings. However, since the CR derivatives were so few this simplification is not believed to have any significant effect on the result. For equity derivatives SA-CCR requires a division into entities such as for example Ericsson. This was not taken into account in this study. Instead the only division that was used was the distinction between single name and index related EQ derivatives. As for CR derivatives, this generalization will not affect the result significantly due to the low part of EQ trades in the portfolio. However, the limitations due to both these simplifications as well as the low number of trades in these asset classes (which applies for CO as well) implies that it might be a subject for future research to investigate how SA-CCR will affect EQ, CR, CO derivatives in more detail.

Furthermore, the supervisory delta adjustment for options was set to -1 or 1, like for most other derivatives, instead of using the definitions in Table 5. The reason for this was that the prices for the underlying instruments were complicated to extract. If the correct definition was used it would still be bound by -1 and 1. However, this could be implemented correctly and studied in detail for a further understanding of the new method.

Moreover, no analysis where performed on how a transition from CEM to SA-CCR will effect trades with respect to their time to maturity. This should also be subject for future research as well as investigating how the method performs and varies over time.

Due to the somewhat limited selection of trades with some instrument types completely excluded, all the potential effects of changing from CEM to SA-CCR were not be captured. Sub-netting sets was not applicable for the selected portfolio so the effect of sub-netting sets has not been observed.

Furthermore, the results are also affected by the specific portfolio used in the study. This portfolio reflects exposures to institutional counterparties which has certain properties regarding factors such as size and margin agreements. Thus, this must also be taken into consideration when interpreting the results.

28 Last words

As concluded, SA-CCR is far more complex in comparison to CEM. Implementing the method will require some effort, especially for smaller market participants that may not have the infrastructure in place for extracting all the required information from their systems for conducting accurate calculations under SA-CCR. Even if SA-CCR proves to be superior to CEM in capturing the risk the complexity of the method increases the probability for systematic errors. It is commonly known that there is a trade-off between complexity of a method and its ability to describe the reality. Since the focus of this study was the overall levels and netting effects, evaluation of the performance of SA-CCR in capturing the risk over time is subject for future research. This can be done by stress testing the method with historical scenarios or simulation. In addition, investigating how SA-CCR will effect CVA risk and the leverage ratio will also be subject for further research. Extending the analysis to other derivatives than OTC would also be interesting since Basel III now requires banks to hold capital for cleared trades. Therefore it would be interesting to study how SA-CCR performs for this purpose.

We want to end this report by saying that SA-CCR is of course a warmly welcomed initiative to replace CEM which is indeed ready for retirement after over 20 years of faithful service in the counterparty credit risk management.

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